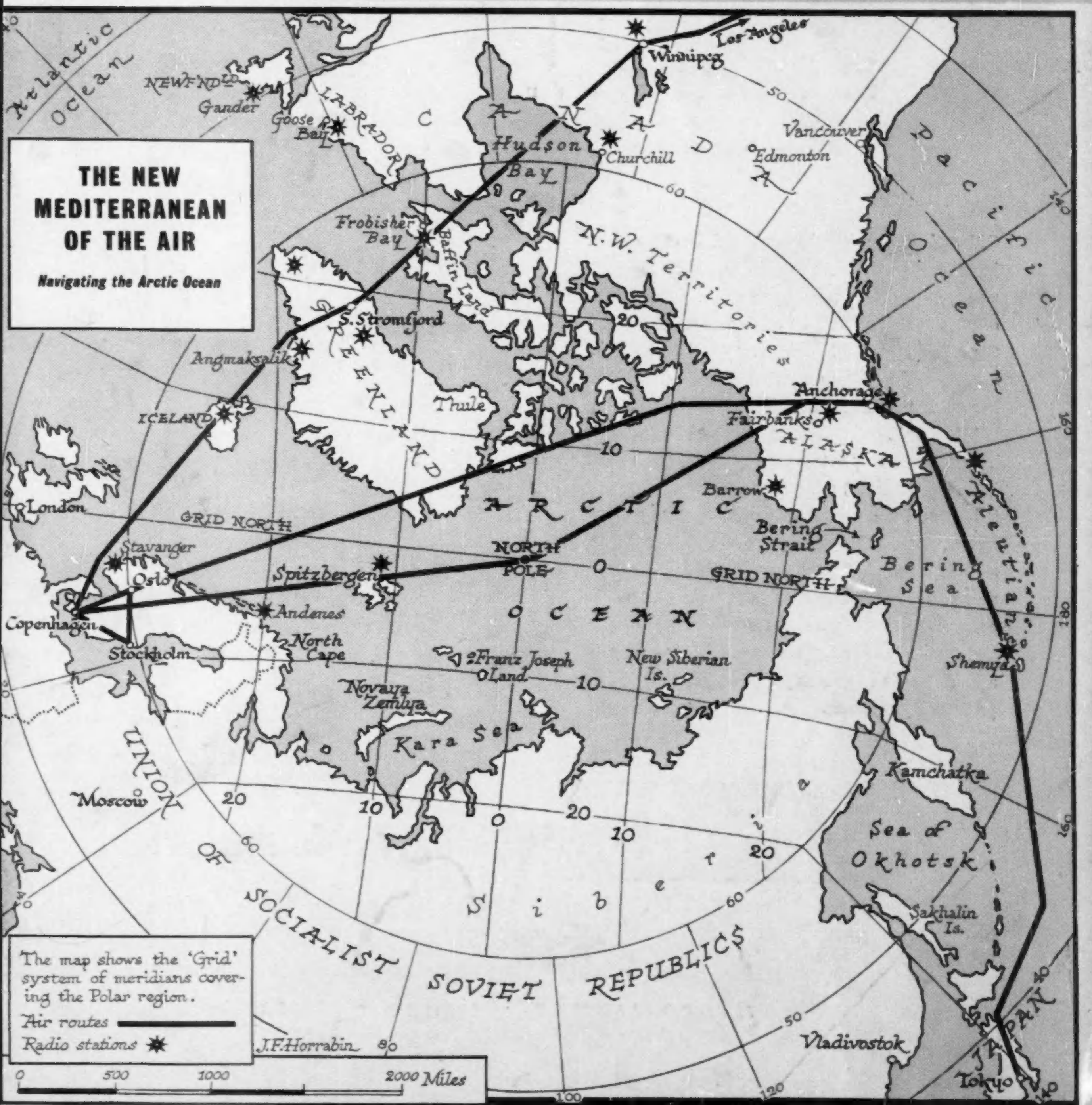
DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

JANUARY 1959 2/6

THE NEW MEDITERRANEAN OF THE AIR

Navigating the Arctic Ocean



DISCOVERY

VOLUME XX **JANUARY 1959** **NUMBER 1**

Editor
Anthony R. Michaelis, PH.D., B.SC.

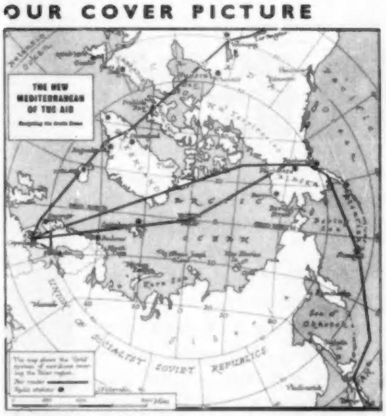
Editorial Office
244 High Holborn, W.C.1
CHAncery 6518

Subscription, Distribution and Business Communications to
Jarrold & Sons Ltd, Norwich
Norwich 25261

Advertisement Office
Aldridge Press Ltd,
27 Chancery Lane, W.C.2
HOLborn 8655

CONTENTS

OUR COVER PICTURE



Map showing SAS routes over the North Pole and Arctic Ocean and particularly the Grid Chart. (See p. 10).

SCIENCE AND POLITICS

Our Ideal—when Philosophers are Kings . . .

A year ago we pleaded for a strategy of science. During the following months we have, on this page, considered how a long-term strategy could be applied to our general economic problems, to transport policy, trained scientific manpower, energy resources, and food supplies, and how such a strategy could lead to solutions of baffling problems. But there is still a more basic issue to be discussed—the relation of politics and science.

Two major scientific events, the International Geophysical Year and the advent of artificial satellites, focus our attention on the interplay of scientific and political decisions. Both these events have demanded scientific manpower and materials which must be reckoned in millions of any participating country's currency, and these millions have been made available by politicians for scientific research—in the case of satellites to a certain extent for military research too. The crux of our dilemma lies in the question: will politicians continue to make an increasingly major part of their countries' resources available for scientific work which they are unable fully to comprehend?

Accordingly, we have pleaded for the long-term view of the future. If we look ahead to the year 2000, as industry—for example, Shell—is already doing, who will then rule, the scientist or the politician? Both alternatives appear at present equally evil. If sovereignty is retained by parliaments and governments who are to a large measure scientifically untrained and scientifically uninformed, the progress of science itself will be greatly hindered. If, however, the real authority slips away from elected representatives into the hands of technocratic managers, answerable only to themselves, the results would bring a certain form of efficiency but disaster to the many human values which we want to retain. The only apparent solution to this dilemma involves the synthesis of the twin roles of science as a fact-finding research technique and as a philosophy of life. Such a synthesis is light-years away.

But what is the reason for this disharmony between science and politics? Most basic is the lack of communication between these two professions which, quite literally, speak different languages. Scientists have often, and quite rightly, been blamed for this, and they could learn much from politicians of the art of putting their ideas over to the general public. Scientists must also press for a much greater share of time on television, a medium which they themselves have created, so that their work can become clear and inspiring to modern mass audiences. But the lack of communication must also be blamed on politicians and other laymen, who neither have the desire nor have taken the trouble to learn the rudiments of understanding for themselves. The disharmony of science and politics is also due to the different atmospheres in which their daily work is performed. The politician is forced by circumstances, for example popular grievances, to make snap decisions on the basis of incomplete knowledge. Scientists can make long-term plans and pursue them methodically. Even engineers, who may, like politicians, have to take decisions at a moment's notice, can rely on the solid data of the pure sciences.

This divorce is not exclusively one of science and parliament. It extends through our whole machinery of government, in industry, education, and other spheres. Only a small number of Ministers of the Crown, and Members of Parliament have had a scientific training. Furthermore, the position in the higher echelons of the Civil Service and other important areas where decisions are made is equally serious. Only in limited sectors of industry is the picture changing significantly and there only where the pressure of competition is acute or the industry itself is of a scientific nature. It is true, of course, that many Government departments have appointed scientific advisers in recent years. However, these scientists are in a position of inferiority to the administrators, for they are regarded as experts and therefore on tap, but not on top. So long as science has this inferior role in national life, the breach will be deepened and not healed.

Admittedly, two bodies exist whose work it would be churlish not to recognise. Within the Government machine the Advisory Committee on Scientific Policy guides and helps the Lord President. In Parliament itself the Parliamentary and Scientific Committee works to forge new links between Science and Parliament. But the fact remains that these activities are basically advisory in character and outside the main stream of the vital issues of policy-making.

To take but one example, the question of decision-making; how far has there been a scientific appraisal of the process in the Government itself? How is it ensured that the voice of science is heard when decisions of a scientific nature are taken at the highest level? The important lessons of operational research, so dearly bought during the last war, appear to have been largely forgotten. There must be many illuminating examples of the disharmony between science and politics which are never reported. From America we learn that during President Eisenhower's first conference to consider the implications of the Russian *Sputnik* not a single working scientist was present. Similiarly there must be many Cabinet meetings in this country where the voice of science is neither heard nor sought. The situation, however, is not without hope, and on the following pages are set out the thoughts of two working politicians and of a famous political scientist. Here we must concentrate on the simple proposition that any Government must learn from science to take the long-term view without which all policy-making is mere muddling-through. Hence our editorials of the last year: we shall continue to examine other political and social problems where scientific method can provide an answer. For it is still only too true, as we pointed out a year ago, that too many people think of the past and present, and not of the future. Thus we agree with the Prime Minister, who recently said when opening the Rolls-Royce test plant at Derby: "The past must be a springboard, not a sofa." Both politicians and scientists must give a lead to the public if

this elementary truth is to be realised. This should be by no means impossible in a mature and responsible democracy.

Just as the real problems that face us involve decades and not weeks, so the final solution must be of a long-term character. If there is to be a growing understanding between science and politics—such as we saw during the International Geophysical Year—there must be deep-seated change in the character of our national educational policy. By this we do not mean an increased number of scientific specialists, important though this is, but a change in the content of education to a position where scientific concepts and discipline are accepted as part of the humanities. Although there is now a growing awareness of this need, there can be little or no satisfaction of the progress made so far. But whatever happens, it will be at least one or two generations before this process can come about of its own accord.

In the meantime every possible short-term solution must be followed up. There is a crying need for many more scientists to enter public life. Many eminent men have drawn attention to the danger of the House of Commons becoming a full-time occupation, inadequately reflecting the broad trends of social evolution. It is, moreover, noteworthy how few scientists are to be found in the House of Lords, compared with the soldiers, the bishops, the judges, and the former colonial governors.

Truly, the big issue of our time is one which Pluto recognised nearly 2400 years ago:

> "Unless philosophers bear kingly rule in cities, or those who are now called kings and princes become genuine and adequate philosophers, and political power and philosophy are brought together, and unless the numerous natures who at present pursue either politics or philosophy, the one to the exclusion of the other, are forcibly debarred from this behaviour, there will be no respite from evil. . . ."

A LABOUR VIEWPOINT

Rt. Hon. ALFRED ROBENS, P.C., M.P.

House of Commons, London

Alfred Robens was born in 1910 and educated at a secondary school. He became a full-time official of the Union of Shop, Distributive and Allied Workers and, in 1926, joined the Labour Party. He was Member of Parliament for Wansbeck from 1945 to 1950, and in the redistribution in 1950 became Member of Parliament for Blyth, Northumberland. He was a Member of the Parliamentary Delegation to U.S.A., Canada, and Bermuda in 1946, and since 1951 he has been a Member of the Parliamentary Committee and the National Council of Labour. He was created a Privy Councillor in 1951 and is a front bench spokesman of the Parliamentary Labour Party on Labour, Fuel and Power, and Science.

Science and the People

The application of science to industry is transforming all our lives at a speed and a pace never previously realised. But even so, the surface has been but barely scratched. The main fact about science today is that there is not enough of it. We have not applied to the greatest possible extent in industry the scientific discoveries which have already been made, and there is a vast field of research of all kinds to be covered for which at the moment there are neither the scientists nor the resources. Not long ago the Advisory Council on Scientific Policy stressed that the resources devoted to civil research and development have been, and still are, far too small for a country whose competitive position in world trade is dependent upon the economic development of new products and new processes, and where the achievement of a rising standard of living must depend mainly upon our success in increasing the productivity of the labour force.

In the competitive world in which we live today, Britain can no longer look forward to the kind of trading in the next century that she enjoyed and experienced in the last. The economy cannot stand the import of vast quantities of raw materials to be fabricated into goods for resale. Britain's exports must contain the minimum of material and the maximum of skill and brains. Britain will need to sell brains and not just brawn. And Britain will never be able to maintain 50 million people on a small island unless she is producing those things that the bulk of the rest of the world find it impossible to manufacture. Today it is the atomic power station and the radio telescope. Tomorrow other countries will be manufacturing these, and we must be developing always that step ahead of the rest of the world. Once other nations with vaster natural resources catch up with the British genius for inventiveness then our economy can easily take a nose-dive. I know nothing about science except what any intelligent layman with a desire to know can discover and understand for himself. But I know what happens in industry when we apply scientific knowledge and research to production. Without the tremendous contribution that science can make to increasing productivity in industry and commerce, making our manpower four and five times as valuable, there is little or no hope of the continuing rise in our standard of living; similarly, we cannot make the maximum contribution to the development of the newly awakened nations. We shall not be able to feed the hungry mouths of the extra millions each year who are saved from death at birth or early childhood by the miracle of modern science in the medical field.

So when I say that the main problem about science is that there is not enough of it, it is apparent that the need for more and more scientists, as quickly as we can get them, brooks no delay. We need urgently more scientists, engineers, technologists, and technicians. But all well-meaning plans to secure greater numbers could quite easily founder on the shortage of teachers of science and mathematics.

We need to educate the whole population to live in a world so largely conditioned by scientists.

For us as an industrial nation the key points for advance are atomic and thermonuclear energy, automation, including the development of the necessary machine tools and scientific instruments, advances in steel production and chemicals, and the application of a coherent, comprehensive national policy for fuel and power. It is in these basic fields that increased efforts would strengthen and broaden the base for a tremendous advance and expansion of the economy.

So far all our estimates of the size and breadth of scientific activities have proved to be too small. Immediately after the war, efforts were made to estimate the demand and requirement for scientists, engineers, and technologists. But it turned out to be an under-estimate. The truth is that the scope of research, development, production, and process control is so vast that there is hardly ever likely to be a time when we can say that we have sufficient, either of the trained manpower or the buildings and equipment for them. The possibilities are so vast that the limitation will always be determined by the total resources that we have available in this field.

There can therefore be no occasion when scientific manpower and equipment is so lavish that the country can afford to waste them, or indeed, in my view, have them engaged upon programmes which do not fit the essential requirement of the national need.

We need, therefore, a programme and a list of priorities. This is a Government task because it is State influence that determines teachers' pay, university grants, construction of the necessary educational buildings, technical colleges, and so forth. A Government determines the proportion of technical resources to be spent on defence research, development, and production control. Research in private industry is very largely determined by Government contracts, and therefore a Government must itself know where it is going, what proportion of the national resources are to be spent on science and technology, and exactly what the short- and long-term programmes should be, taking into consideration all the factors known only to a Government. The Advisory Council on Scientific Policy estimated that "not far short of half the total number of scientists and engineers employed on research and development in Great Britain in 1955–6 were employed on defence work, whilst at least 59% of the expenditure on research and development was on defence . . . the resources devoted to civil research and development have been, and still are, far too small". And there we have the matter in a nutshell. It is no part of my task to argue whether the proportion spent on defence is too large or too small. Assuming that all the expenditure both of scientific manpower and finance was necessary, it is obvious that there needs to be a big expansion of both manpower and finance for research if the civil side is to be effective or sufficient.

There is need for the greater co-ordination of scientific work if the maximum efficiency is to be got from present resources. This, however, cannot be the task of the politician. This can only be worked out by a Government with the fullest consultation and co-operation of the scientists, engineers, technologists, industrialists, and others. The task of co-ordination would be to work out on the broadest possible lines the practical programmes over the next five, ten, fifteen, and twenty years with a constant review in the light of practical progress made and new discoveries and developments.

We should seek to ensure that the maximum application of scientific knowledge is applied to industry in the shortest possible time. This will inevitably mean some industrial reorganisation, but we might just as well realise now that the scientific revolution in the second half of the 20th century is, in its way, going to make just as big a change in industry and the lives of the people as the industrial revolution made in the first half of the last.

My plea, therefore, could be summarised briefly as urging the need for the greatest possible expansion of scientific manpower, a bold and progressive programme with short- and long-term priorities in it, and a Government playing a positive, but not dictatorial role in co-ordinating the scientific direction of the country.

There is not a single field of human endeavour in which science is not able to render tremendous service. We ought to create the kind of climate in which scientists and those associated with them feel that they are welcomed and that their endeavours are concentrated upon the elevation of mankind.

A CONSERVATIVE VIEWPOINT

SIR EDWARD BOYLE, M.P.
Parliamentary Secretary, Ministry of Education

Sir Edward Boyle, who is now aged 35, has been Parliamentary Secretary to the Ministry of Education since the formation of Mr Macmillan's Government in January 1957. He was educated at Eton and at Christ Church, Oxford, and while at Oxford was President of the Union and took part in the Union's debating tour of the U.S.A. in 1947–8. He entered Parliament in November 1950 as member for the Handsworth Division of Birmingham which he has represented since then. His first Ministerial post was as Parliamentary Secretary to the Ministry of Supply from 1954 to April 1955, when he became Economic Secretary to the Treasury, a post he held till his resignation from the Government in November 1956. At the time of his entry to the Government he was its youngest member and he is still the youngest of those with Departmental responsibilities.

History and Technology

Just what do we mean when we speak of ourselves as living in a "technological age"? When I studied History at the university, my tutors used frequently to point out that history does not really divide itself neatly into the various "ages" that one encounters so frequently in the textbooks. And the truth is, rather, that technology has played a part—often a highly important part—throughout the whole of recorded history. Let me just give one or two examples of this. The 16th century was the Age of the Renaissance and the Age of the Reformation; but it was also the Age of the printing press and the windmill, the pump and the pulley—in fact one can say that, by the 16th century, the Industrial Revolution was already on the way. And then, again, you simply cannot understand the course of history without paying considerable attention to the art of war, and here the progress of technology intrudes all the time. We live, today, in a society which is organised primarily for peaceful purposes. But our medieval ancestors did not; Anglo-Norman England, during the period between the Battle of Hastings (1066) and the signing of Magna Carta (1215) was essentially a society organised on a military basis. And one simply cannot hope to understand Medieval England unless, among other things, one knows something about the evolution of the medieval castle, from its humble beginnings as a fortified strong-point to the days when the advent of gunpowder rendered it obsolete.

Furthermore, not only has technology been of great importance in earlier centuries, but in addition I think we should be chary about supposing that our contemporary technological achievements are more remarkable and more praiseworthy than those of earlier centuries. Certainly it has been a colossal achievement to have constructed Calder Hall. But it was also a colossal achievement to have constructed the Clifton Suspension Bridge just over a century ago. Indeed, if anyone feels inclined to minimise the work of 19th-century inventors, I suggest that he takes a walk across the Clifton Suspension Bridge, and then just looks and thinks. Incidentally, it is worth recalling that this bridge was the work of Brunel. No country's industrial history has ever owed more than our own to the ingenuity and skill of inventors of alien origin. We should be the least entitled of all countries to adopt a posture of "Britain for the British".

THE MEANING OF TECHNOLOGY: HUME AND HARDY

And then, again, not only is there nothing new about technology itself, but there is also nothing new about thoughtful writers reflecting on its meaning and significance. I know that some people do not care very much for the writings of "intellectuals", and will not consider this point of any great importance. But for my part I always find it particularly interesting when one discovers men of a bygone century who obviously minded about the same things as one minds about oneself. And I will give just two instances of men who clearly thought, and also felt, a good deal about the implications of technical progress. The great 18th-century philosopher David Hume, writing 200 years ago, before the Industrial Revolution really got under

way, remarked in his "Essay on Commerce" that few things were more important in any society than what he termed "progress in the mechanical arts". And he went on to say that it was highly desirable that as many men as possible—and not just a selected few—should own "all the necessities and most of the conveniences of life". Hume lived in a period when most writers on Economics still believed that the prime object of trade and industry was to procure wealth for the nation, so that its stock of precious metal was greater than that of its neighbours. I shall always regard him as one of the very greatest of British (and, incidentally, Tory) thinkers, precisely because he realised so clearly that the ultimate object of material improvement was the benefits which it brought to the ordinary individual. I return briefly to this point later on.

My second example is not a professional thinker but an imaginative writer. Thomas Hardy's novel, "Jude the Obscure", is not only the (somewhat mawkish) tragic history of an aspiring working man "with an uncomfortably warm sexual temperament"; it is also a story of the impact of modern rail communications on the deep rural area of "North Wessex"—that is, the Berkshire Downs. It is not just clumsiness on the part of the author that causes so large a part of the action in this strange novel to take place during train journeys; and it is also interesting to notice that two of the most powerful and convincing episodes—Jude's escapade with Sue that led to her absconding from her training college, and Jude's farewell visit to Sue—both depend for their plausibility on the absence of easy communications by road when a train was not available. One can say with truth that this is a novel which could only have been written during the period that elapsed between the completion of our railway system and the advent of the motor-car.

TECHNOLOGY TODAY

For all these reasons, therefore, I conclude that we must be very careful before we advance any claim that ours, and ours alone, is a technological age. But now, having done justice (I hope) to the threat of continuity in the history of technology, I must pass on to consider those respects in which the position of technology today is markedly different from the position of technology in any earlier period. And in this context one must, surely, place first the almost incredibly rapid rate of scientific and technological advance during the present century. I shall just cite one example, which seems to me a highly revealing one. A. N. Whitehead, in his well-known book, "Science and the Modern World", remarked that the greatest invention of the 19th century was that of the *power to invent*; and he cited as an example of this thesis the difference between the apparatus which Newton needed to prove his theory of gravity, and the highly complex apparatus which Michelson and Morley had to invent in the 1890's in order to carry out their crucial experiment which disproved the existence of "ether". This has always seemed to me a highly pertinent and revealing comparison. But supposing that Whitehead had been two generations younger, and that he was writing a similar book today; how much more strongly he could have reinforced his point by comparing the apparatus needed for the Michelson-Morley experiment with the apparatus needed for ZETA. And he could have gone on to stress the contrast—no less striking—between the manpower needed for scientific and technological progress in Newton's time, the 1890's, and the present-day world.

At the same time, however, I think it is possible to get things out of focus if one thinks of scientific and technological advance purely in terms of such developments as ZETA, the hydrogen bomb, and the exploitation of nuclear power for peaceful purposes. Quite apart from the pace of this advance, surely one of its most striking features is its scope, even down to tiny things that one can easily overlook. Here again, I am going to cite just one example. We hear a great deal these days about "stereoscopic sound" and every music-lover must certainly be immensely grateful for the vast improvements, both in recording and in sound reproduction, during the last decade. And yet I cannot, myself, regard the achievement of "3-D sound" as the most important development that has taken place during the five years or so that I have been a fairly regular buyer of long-playing records. Five years ago, as very many people will confirm, practically none of the main record companies provided an inner cover between the record itself and the "sleeve"; quite often, indeed, the sleeve was so close-fitting that it was difficult to take out the record without making some abrasion, however slight, on the playing surface. But today, polythene inner covers are almost universal, with the result that one can keep the playing-surface in perfect condition over a period of years. I am sure I am not alone in regarding this improved service—to which relatively little reference has been made in the Press—just as relevant to one's enjoyment of the gramophone as the best reproducer in the world. The highest quality of reproduction cannot conceal a slightly damaged surface—in fact it exaggerates it. When we are considering the significance of technological progress, do not let us ever forget that a multiplicity of small developments can matter every bit as much as one really big development.

TECHNOLOGY AND MANPOWER

Now I must pass on to manpower. The second respect in which the position of technology today is so markedly different from its position in any earlier period lies in the number of scientists, technologists, technicians, and craftsmen that are needed in a leading industrial nation such as our own. (Incidentally, I should mention that I have included "technicians and craftsmen" in this list quite deliberately; it is no good having the best atomic scientists in the world, or the ablest technologists, unless one also has a sufficient supply of technicians and craftsmen to back up their labours.) There are really four main reasons why this requirement is so great. In the first place, there are the needs of defence. One of the things that impressed me most during my period at the Ministry of Supply was the enormous multiplicity of highly technical jobs which had to be carried out satisfactorily during the development cycle of a modern military aircraft. For instance, I well recall that the actual physical task of fitting and testing the aerial system used to present quite a problem. The aircraft firms themselves had not the necessary technical personnel, while the electronics firms were naturally unwilling to expose one of their best men to the risks of an accident during the early stages or development. In the upshot, nearly all these problems used to be passed on to the

establishment at Farnborough which tended in consequence to become grossly overloaded with work. However, it would be a very great error—as the present Minister of Supply, Mr Aubrey Jones, has so cogently pointed out—to imagine that the Defence Programme has been nothing more than a dead weight on the British economy. Our civil industries have, in fact, gained a great deal, both directly and indirectly, from the Defence Programme, and it is surely highly significant that every aero-engine which has been exploited successfully for use in a civil aircraft was first tried out in a military aircraft.

The second reason why the requirement for scientific and technological manpower is so high is because of the needs of our export trade. If Britain is to pay her way in world markets that are becoming all the time increasingly competitive, then it is obviously essential that British industries should be both highly efficient and continually re-equipped. We have, as a community, stepped up our exports since the war to a very remarkable extent, and we have done so by paying special attention to industries which embody new techniques, and where there is a high ratio of fixed capital to the number of workers employed. But it also goes without saying that it is the most up-to-date industries which require the most highly skilled managers and men. Anyone who visits a modern steel mill or a cold reduced rolling mill for producing steel plate, must be fascinated by the spectacle of so impressive a mass of industrial power producing so much with so little manpower. But one has only got to consider the humdrum—and vitally necessary—task of maintaining these mills to realise that these last engines of progress can only work against a background of thorough training and highly specialised skill.

The third source of this very heavy requirement for scientific and technical manpower is, quite simply, the needs of a modern democracy. As a country grows in wealth, and as this wealth becomes more widely diffused throughout the community, there is bound to be an increased demand for capital expenditure of very varied kinds. For instance, an increase in the number of people who can afford a home of their own will not only give greater employment to architects, but it will also entail a need for higher investment in electricity, road building, water, and sewerage. Or again, a large increase in the sale of cars makes an almost immediate impact not only on the car industry itself but on the steel industry and the machine tools industry as well. And then (no less important) it may be that the Government itself will initiate reforms that call for higher capital programmes. Quite obviously you cannot introduce a revolutionary policy of full secondary education for all children without creating the need for a far heavier programme of school building than ever before. Now all these programmes of capital expansion not only place an economic burden on the nation's resources, but they also call for a very wide range of highly trained men and women. We need experts today in so very many fields if we are to meet the claims on our resources which will quite certainly be made during the years that lie ahead.

Lastly, I cannot do more than just make a bare mention of the need for technical manpower in assisting the underdeveloped countries of Asia and Africa. But it is just worth remembering that when, say under the Colombo Plan, Britain agrees to make a given amount of technical assistance available over a term of years, then it is not only money that we are talking about but trained men as well. It is no use sending off tractors to a backward community if they are just going to be allowed to rust.

EDUCATION FOR TECHNOLOGY

At this stage a reader may feel inclined to ask: "How, in view of all that you have said, can we in Britain secure the number of scientists, technologists, technicians, and craftsmen that we require?" I shall not attempt to go into detail in answering this question, because if I were to do so, I should merely be repeating what has already been far better expressed in Ministerial publications and pronouncements. But there are four general points which do seem to me to bear emphasis. First, there really can be no substitute for first-class mathematical teaching in the primary schools; even if one has the best technical colleges in the world, they will never be utilised to the fullest advantage unless children receive a thorough grounding in the rudiments of number at an early stage of their school career. Secondly, one has always to remember that it is not good enough merely to produce a limited number of absolutely first-class scientists and technologists. As I have already remarked earlier, these have to be backed up by technicians and craftsmen; and the teamwork which is so prominent a feature of modern technology requires an adequate supply of competent betas just as urgently as it requires the inspiration of a smaller number of alphas. Now these "competent betas" must be the products, in very large measure, of our secondary modern schools. And I do not think it is too much to say, in this as in so many other contexts, that the raising of standards in our secondary modern schools is one of the two or three most important tasks which faces the nation during the second half of the 20th century.

Thirdly, it is obviously important that a higher proportion of the ablest pupils in our grammar schools, direct-grant schools, and independent schools, should study science in the sixth form. I am not saying that they should attempt to reach a high specialist standard in any one branch of science before they leave school. On the contrary, most observers seem to be agreed that it is far better to acquire a really thorough grounding in general science before one attempts to specialise in, say, chemistry or physics. I know there are still some people who seek to draw a sharp contrast between "science" and "the humanities", but I have little doubt they are wrong in so doing. It is possible to teach any subject in a more humane or less humane manner; I think it was Prof. J. B. S. Haldane who once remarked, very fairly, that a good systematic course in Botany, taught on the lines of Greek Grammar, could be guaranteed to inoculate any child against any further interest in science for the rest of his life. Conversely, I see no reason at all why general science should not be taught in a humane manner, especially if some attention is paid (as it certainly should be) to the history of science and technology as well. Finally, it is no use thinking that the Government by itself can ensure the success of our programme for technical education. This is, rather, a matter for continual co-operation between the Ministry of Educa-

tion, the Local Education Authorities, the universities, and (by no means least) industry itself. It is also an extremely welcome sign that the Press, and public opinion generally, is so much more alerted than ever before to the importance of educational topics.

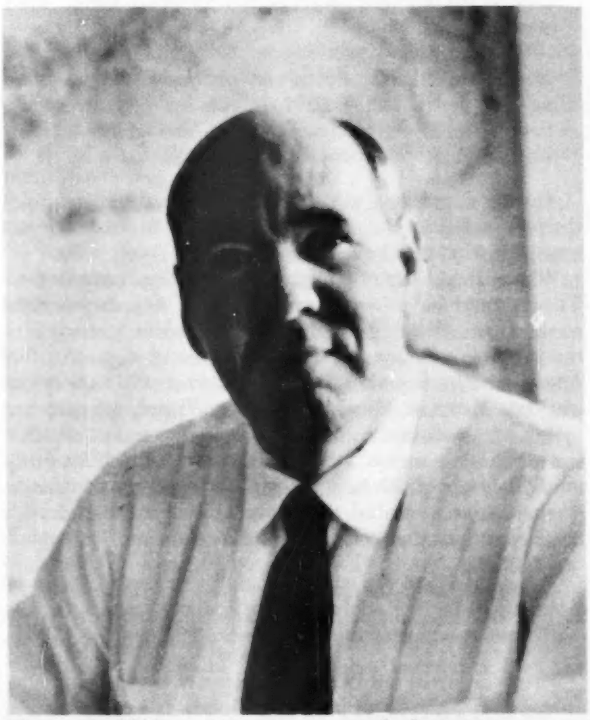
HUMAN WELFARE, THE AIM OF TECHNOLOGY

I should like in conclusion just to add a very few words about what one might term the "why and wherefore" of science and technology. Just what is the object of it all? In answering this question, I should like to harp back, just for a moment, to the views of David Hume which I quoted in an earlier paragraph; because it is surely so very important to remember that the ultimate object of all scientific and technological progress is to be of benefit to individual men and women. Totalitarian countries, whether Fascist or Communist, tend to worship industrial power for its own sake; they see in it a symbol of national grandeur. I think it is fair to say that we in Britain have never fallen into this error, and I most earnestly hope that we shall never do so. Calder Hall is certainly a most impressive sight, and one feels that its construction was almost as great a feat as what goes on inside it. But what matters most about Calder Hall, or any other manifestation of industrial power, is its meaning and significance from the point of view of human welfare. The prime object of technological advance must always be to remove avoidable causes of unhappiness and misery from as great a proportion of the human race as is humanly possible; and its secondary object is to enlarge the range of choice, and to open up the possibilities of a freer and fuller life, for those who have advanced in wealth beyond the level of mere subsistence.

A SCIENTIST'S VIEWPOINT

Prof. C. NORTHCOTE PARKINSON

Formerly Raffles Professor of Modern History, University of Malaya



C. Northcote Parkinson was born in 1909. Although a Yorkshireman, he was brought up at Barnard Castle, Co. Durham, and educated at St Peter's School, York, and at the Universities of Cambridge and London. In turn he has taught at several academic, naval, and military institutions. Perhaps his most valuable education, however, dates from his work in the War Office and the RAF during World War II, for it is known that from this experience "Parkinson's Law" came into being. Prof. Parkinson has specialised in maritime history and he is a Member of the French Académie de Marine and the United States Naval Institute. In 1954 he was appointed Raffles Professor of History at the University of Malaya where he compiled a variety of histories of Malaya and the Eastern Seas. At present he is lecturing in the United States of America. His most recent book is entitled "The Evolution of Political Thought", and was published a few months ago by the University of London Press. The ideas sketched by Prof. Parkinson in this article are fully developed in the book.

Can Politics Become a Science?

Those of us who think that scientific method is applicable to political problems are apt to be told, rather sharply, that we are talking "Scientism" and that this heresy was destroyed by William H. Whyte in his book called "The Organization Man". It is a question, however, whether "Scientism" and Science are exactly the same thing. To Whyte, "Scientism" is the belief that with the same techniques that have worked in the physical sciences we can eventually create an exact science of man. Selecting as opponents the less inspired "social engineers" who had manifestly claimed too much, and calling Hayek and Voegelin to his aid, Whyte easily routed his chosen victims, showing that ethical concepts cannot be measured and that a "science of man" cannot work in the way some enthusiasts suppose. He was able to show the absurdity of identifying "good" with equilibrium or harmony, and "bad" with frustration and tension. Easy victims to his sword

were such physical scientists as had strayed from their laboratories (as nuns might stray from the cloister, as curates might enter a bar-parlour for the first time), proving themselves to be as naïve as such visitors often are. Looking about the stricken field, Whyte concluded firmly that policy can never be scientific and that the contribution of social science to policy-making can never go beyond staff-work.

That "The Organization Man" was an effective assault on "Scientism" need not be questioned. It would be matter, however, for regret if Whyte were thought to have overthrown some opponents he did not even attack. For scientific method did not perish with "Scientism"—the weakness of which is indeed that it is not scientific at all. It is clear, moreover, that "Scientism" grew up in that specially American atmosphere for which the Pilgrim Fathers are often held to blame. It was seized as a gospel by those who had lost the Protestant Ethic, by those in search of a new ideal. But the fact that a chisel has been used as a screwdriver is no proof, in itself, that chisels are useless. And Whyte, in conceding that scientific method is applicable to staff-work, has conceded all that a true scientist should want. In denying that scientific method can be applied to "policy" he has done no disservice to those whose approach is really scientific. He has merely reminded us, and very properly, that political and ethical problems are better studied apart.

What is the distinction, after all, between policy and staff-work? It is the distinction, surely, between the object and the means. To construct a "science of man" with distinctions to be drawn between the good and the bad, would be a problem of aim. To decide on the procedure to be followed in an assembly is a problem of method. It is to problems which are thus narrowly political that the scientific method should be applied. Political organisation is not an end in itself but merely the framework within which human purposes (whether moral, intellectual—or even merely convivial) can be fulfilled. The ultimate aims of society may be ethical or aesthetic but the problems of organisation are neither. To politics in this strict and secular sense the principles of scientific research are entirely applicable. More than that, the time has come when they ought to be applied.

STAGNATION IN POLITICAL IDEAS

For what, after all, is the alternative? History shows us no progress in politics which is even remotely comparable with recent progress in science. It shows us, rather, a sequence in which one form of rule replaces another, not as an improvement but merely as the consequence. The range of choice is between the rule of the one, the few, and the many. In most organised societies of which we have record there is monarchy at first, which creates a nobility by a biological process if by no other. The nobility becomes too strong for the king and eventually seizes power. By natural increase, by diffusion and dilution of its prestige, the ruling aristocracy has to share its power with a widening circle of people. After a certain point in this process the form of rule comes to be called a democracy. This leads to socialism, the movement through which the poor despoil the rich, gradually bringing about a state of chaos. People turn then to dictatorship as a means of ending the chaos. And dictatorship may in time become monarchy, thus completing the cycle and starting the sequence afresh. It would be misleading to describe this sequence as invariable but far less so than it would be to trace any pattern of political progress. As compared at least with the natural sciences, the stagnation in political ideas would seem to be complete. But the effect of scientific achievement is to endow the old political treadmill with a new capacity for destruction. Recurring periods of political chaos seem decreasingly attractive when associated with a high level of technical skill. In so far as science has created a new peril, we are not unreasonable in turning to science for a new remedy.

THE SCIENTIFIC APPROACH

In applying scientific method it is the first step which proves to be the most difficult. It is a step which the prophets of "Scientism" have not even attempted. Whyte describes their position with some accuracy:

> ". . . If ethics is to be scientized, some specific people will have to do it, and some specific people are going to have to see to it the ethics are applied to society. Who, then, is to be in charge?
>
> "Being most of them democratically inclined, the new utopians take this question very seriously. If manipulating people is bad—and manipulation is one of the dirtiest words in the new lexicon—how can one justify the manipulation of people for good ends?"

This is a problem still being seriously discussed. But there is a fallacy in all this twaddle. The theorists are assuming what they have to prove.

Where, then, it may be asked, should they have begun? They should have begun with the first step in scientific method, and that is to admit your complete ignorance of the problem you are to solve. The second step is to feel some real curiosity about what the answer will turn out to be. But the new Utopians, to use Whyte's phrase, are twittering about ethics and democracy. Instead of discarding all these preconceptions, as a true scientist obviously must, they are still befogged by all they learnt at college. They have not cleared their minds of cant. Faced with theories such as theirs, Roger Bacon exclaimed:

> ". . . If I had my way I should burn all the books of Aristotle, for the study of them can only lead to a loss of time, produce error, and increase ignorance. . . ."

The quantity of books which are today increasing ignorance would come to an impressive total. It would be well, however, if ignorance was all that they produced. For the chief obstacle to progress is not ignorance but knowledge; and just such knowledge as medieval physicians had of medicine. They were all stuffed with information, approved by the Faculty, acquired in lectures and displayed in examinations. They knew all there is to know about the habits of the unicorn and dragon. They knew the importance of the horoscope and they had learnt the peculiarities of the salamander. They had piles of books dealing with all aspects of medicine. But medical progress dates, in fact,

from the moment when the physician stopped looking at the books and tried looking at the patient. In the field of politics that is a moment we have not yet reached.

Supposing, however, that we gain the first step, and then the second, how do we proceed from there? First of all, we shall have realised that scientific progress is from step to step and one at a time, and that each step rests not on theory but on fact. We shall then grasp that the questions commonly propounded are at present insoluble. If asked way and where? But if the question were rephrased in the question is meaningless. Best for whom and in what way and where? But if the question were rephrased in more exact terms, we should have to admit that our researches have only just begun. Good government is that which governs well. Its effectiveness is measurable in terms of population, fertility, health, education, efficiency, economy, public spirit, and obedience to law. Its further effect is less certainly measurable in terms of learning, literature, drama, music, and art. Careful investigation of all that has been achieved might reveal, to begin with, some tentative grounds for thinking that there may be an optimum size for the political unit. It might perhaps be shown that states tend to stagnate when too small and become inefficient when too large.

BASIC INFORMATION NEEDED

If we are to progress beyond these elementary facts about (say) the size of the unit to be administered, we need to call in the aid of the anthropologist, the historian, the psychologist, the statistician, and the specialist in public health. With their help we might attempt a further set of problems. What should be the number, age, and sex of persons to whom authority is to be entrusted? How long should a meeting be allowed to last? What should be the rules of procedure? We need information of this kind before we can reach the conclusions upon which further progress can be based. We also need some careful investigation of what the mass of people want and need and of how (if at all) their views can be usefully expressed. In this way we might eventually reach the point at which the merits of monarchy and aristocracy, democracy and dictatorship could be compared. At present the means of comparison simply do not exist.

The Thoughts of Alfred Nobel

The 125th anniversary of the birth of Alfred Nobel occurred recently. He was the son of an unsuccessful Swedish architect, Immanuel Nobel, who established a flourishing business by making sea-mines for the Russian fleet, but failed again when peace returned after the Crimean War.

At his father's suggestion, young Alfred began to experiment with nitro-glycerine, which had been discovered by the Italian chemist, Sobrero, at Turin in 1847; Prof. Sinin in Russia had demonstrated its blasting power to Immanuel Nobel.

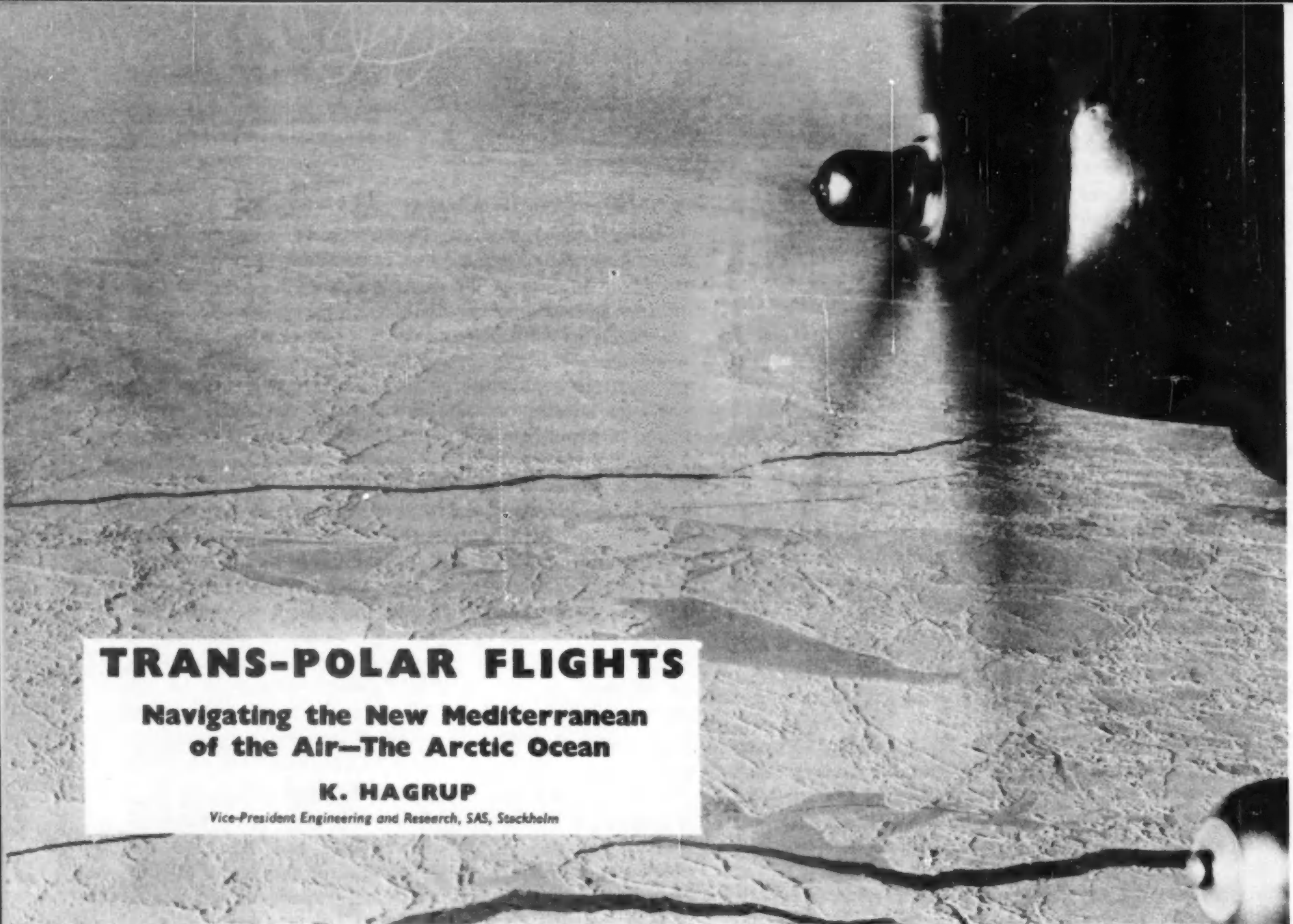
Within a few months he set up a nitro-glycerine factory in Hamburg, and began to sell his "explosive oil" all over the world. Almost every week, however, some dreadful accident occurred; the impurities in the oil often ate little holes in the containers so that it would ooze out, and careless handling of the explosive in the mines, in factories, arsenals, and during transport cost many lives. Nitroglycerine, in its liquid form, was so dangerous that many countries, including Britain, introduced special laws amounting to a virtual ban on its import and manufacture. Only when the liquid nitro-glycerine was absorbed in *kieselguhr* did it become safe to handle; thus Nobel created dynamite.

Within a few years, Alfred Nobel became one of the richest men in the world. The first dynamite weapons were some German shells fired into the densely populated Montmartre during the siege of Paris in 1871.

He was still in his early forties when he retired from active research work to concentrate on his ever-growing business empire, which eventually included oil-fields near Baku, pipelines, refineries, and a fleet of tankers, operated by his surviving brothers. Living and working in his villas in Paris, Switzerland, and on the Riviera, he seemed to have few personal friends—a lonely millionaire if ever there was one. He never married; perhaps a tragic love-affair in his youth made him shy away from women.

Alfred Nobel was throughout his life a retiring and reticent man whose thoughts and character are difficult to assess. He showed himself callous and sensitive, an idealist and a cynic in turn, but towards the end of his life he appears to have become acutely aware of the moral problems created by his inventions. The Austrian Baroness Bertha von Suttner, author of the famous anti-war book, "Lay Down Arms", exerted a very strong ethical influence on him. Pressed to put his name and money behind the peace movements which began to spring up all over Europe in the early 1890's, he argued that his dynamite "may end war sooner than all these peace congresses". "When two armies will be able to annihilate each other in a flash, all civilised nations will recoil in horror and disband their armies," he said. The problem of the "ultimate weapon", the great deterrent, occupied his mind intensely. "I wish I could produce some material, some machine of such terrible power of annihilation and devastation that it would make wars altogether impossible," he told Bertha von Suttner. "I am thinking of weapons that would make war as deadly for the civilians at home as for the troops at the front. Let the sword of Damocles hang over every head, and you shall witness a miracle—they will all clamour for peace. Perhaps dynamite is not sufficient to achieve this, even if one day it will be dropped from the air. . . . Perhaps wars would stop instantly if that weapon were bacteria."

He never searched for such a weapon, but his testament—found at the bottom of the deepest drawer in his desk, buried under business papers—provided that the bulk of his fortune, about £2 million, was to be used for the promotion of peace, literature, and science. He died in his large house at San Remo, on the Italian Riviera, on December 10, 1896.



TRANS-POLAR FLIGHTS

Navigating the New Mediterranean of the Air—The Arctic Ocean

K. HAGRUP

Vice-President Engineering and Research, SAS, Stockholm

As the pioneers of trans-Polar air flight, the Scandinavian Airlines System has maintained a policy of putting the benefit of their experience at the disposal of other interested airlines. They have made such facilities as radio and radar stations available to others, and have actually trained personnel from other companies.

The story of the search for practical and usable short-cuts along the great circles between Europe and the American west coast and the Far East is 400 years old and includes the names of daring and resourceful men like Columbus, John Cabot, John Franklin, Henry Hudson, Martin Frobisher, Fridtjof Nansen, and others. With the quest for the Northwest Passage went the centuries-old attempt to reach the North Pole. Many men of many nations tried until at last Robert Peary conquered the Pole in 1909.

The assault on the Pole by land had its counterpart later in the air. First to try was S. A. Andrée who made an attempt to reach the North Pole by balloon in 1897. Richard Byrd first made a flight over the North Pole in 1926, and the same year Roald Amundsen was the first to cross the Arctic by air from continent to continent with an airship taking 72 hours. The navigator on this flight across the uncharted territory from Spitsbergen to Teller in Alaska was General Riiser-Larsen who 31 years later was a guest of SAS on the inaugural flight from Scandinavia to Japan via the North Pole; this flight, over the same distance, took some 10 hours.

The main object of these early flights was to explore the Arctic regions for scientific reasons and perhaps also for the sake of adventure. Undoubtedly, there were many who were sufficiently far-sighted to realise the future possibilities of this area in providing aerial short-cuts between points in the Northern Hemisphere. However, because of the modest range of then existing aircraft in relation to the great distances between available airfields, many years were still to pass before any serious attempts could be made to exploit ideas of trans-Polar operations.

FIRST COMMERCIAL ATTEMPTS

It was not until the last years before the outbreak of World War II that the first serious attempts were made to start a commercial trans-Polar air service. This was done by the Russians who for a long time had been gathering knowledge of Arctic flying along their northern coastline, and had established a floating ice station near the Pole for scientific investigations of Arctic conditions. In the summer of 1937 first Chakalov and then Gromov flew non-stop from Moscow over the North Pole to Vancouver and San Jacinto, California, respectively, the latter flight covering a distance of 7000 miles in 62 hours. These flights were made in single-engined aircraft with a crew of three. A third flight made later during the same summer by Levanevsky with a four-engined aircraft ended in disaster, the aircraft being lost somewhere in the vicinity of the North Pole. In the autumn and winter of 1937 many search flights were made.

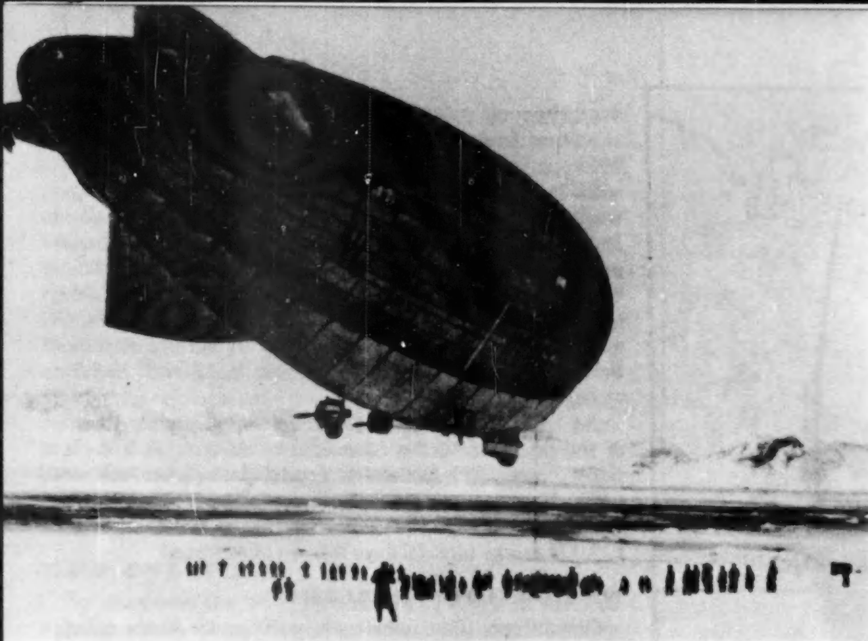


FIG. 1. The Italian dirigible *Norge* in which Roald Amundsen, L. E. Ellsworth, and Umberto Nobile crossed the North Pole in May 1926. They travelled from Spitsbergen to Teller, Alaska, a distance of 3391 miles, in 72 hours.

Then came the war which, for some time, put a stop to all plans for commercial trans-Polar operations. However, the rapid technical development of aviation during these years greatly improved conditions for the future introduction of such flights. Bigger long-range aircraft were built and better navigational and communicational equipment was developed. Furthermore, Arctic airfields were built in Labrador (Goose Bay), Baffin Land (Frobisher Bay), Hudson Bay, and in Greenland (BW1, BW2). This was continued after the war (for example, the big U.S. air base at Thule) in connexion with a period of considerable military interest in Arctic flying. The RAF made a series of survey flights with the four-engined Lancastrian *Aries*. These flights laid the foundation for modern Polar navigation. In 1947 the USAF started their extensive scheme of weather flights to the North Pole from Alaska. More than 2000 missions have been flown. Then followed some Arctic flights which received much publicity and heralded the forthcoming introduction of regular trans-Polar flights; the Arctic pioneer Bernt Balchen's flight direct from Fairbanks in Alaska to Oslo in 1949 and Captain Blair's solo flight in a Mustang single-seat fighter from Bardufoss, Norway, to Fairbanks in 1951.

SURVEY FLIGHTS

If one looks at a globe from above it is evident that the shortest route between many important population centres runs across the Arctic Ocean. This applies in particular to routes from northern Europe to the west coast of the U.S.A. and to the Far East so long as flying over Siberia is forbidden. It was, therefore, very natural that SAS, which was formed in 1946 by the three domestic airline companies of Denmark, Norway, and Sweden with the primary object of establishing intercontinental routes, soon became seriously interested in realising the old dreams of trans-Polar operations, now that conditions seemed to make such plans technically and operationally possible and safe.

It goes without saying that all experience and knowledge gained by the extensive Arctic pioneering of various nations, already briefly outlined, was invaluable to SAS when making the preparations necessary to establish a Polar route. The plans began to take firm shape when in November 1952 SAS routed a Douglas DC-6B on its delivery flight via Edmonton, in Canada, and Thule, in the north-west corner of Greenland, to Copenhagen carrying twenty-four passengers. This first flight was followed by additional successful SAS exploratory Arctic flights during the period 1952 to 1954, which were made to gain sufficient practical experience, particularly with regard to navigation and communications, to enable the company to start scheduled services. The survey flights were not limited to the Polar route between Scandinavia and the U.S. west coast; in May 1953 a passenger charter flight from Scandinavia to Tokyo was routed via Thule, Anchorage, and Shemya (Aleutians), thus becoming the first commercial flight to be made via the Northwest Passage to the Far East. A year later a similar flight was routed directly over the Geographical North Pole from Bodø (Norway) via Anchorage (Alaska) to Tokyo.

INTRODUCTION OF REGULAR ROUTES

In the final stage of preparations to establish the first regular Polar airline there were, however, not only technical and operational problems to be overcome. The biggest obstacle was a military and political one, namely, to obtain permission to use the American military Arctic airfields and to obtain the traffic rights to use Los Angeles as the U.S. terminal of the proposed route. The fact that Greenland is Danish territory and, furthermore, that SAS was represented jointly by all three Scandinavian countries, was a great advantage in the negotiations with the U.S. Government. The rights were finally granted, as desired, except that Sondre Stromfjord (BW8) on the west coast of Greenland had to be accepted as an intermediate Arctic landing-point instead of Thule. Winnipeg, in Canada, was chosen as the other intermediate stop. Finally, on November 15, 1954, the Polar route between Scandinavia and California was inaugurated with Douglas DC-6B equipment. The subsequent favourable development of this route, on which over 60,000 passengers and more than

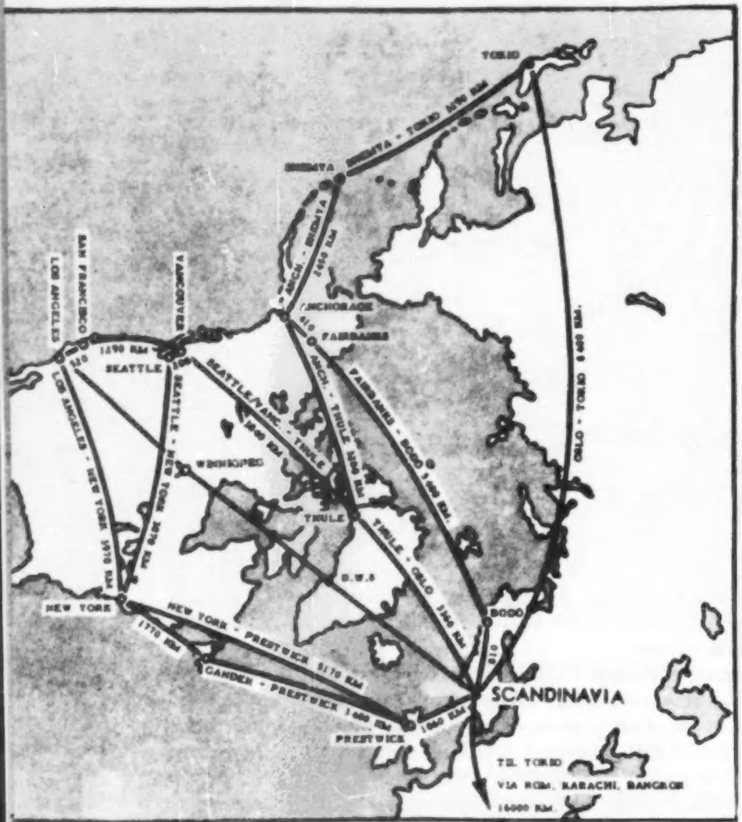


FIG. 2. Great Circle routes from Scandinavia.

1·5 million lb. of cargo have been flown, has clearly shown the potential possibilities of trans-Arctic airline operation. Canadian Pacific Airlines, with its vast experience of domestic operation under Arctic conditions, was the second airline to establish a Polar route between North America and Europe via Sondre Stromfjord.

Although the Polar route between Scandinavia and California was the first to be inaugurated (1954), plans for another route had been made before this. These were the plans for a regular route from Scandinavia to Japan over the North Pole. The fact that Thule would not be available as an intermediate landing field meant that plans for a route from Scandinavia to Japan had to be altered. As it turned out, the new DC-7C with its tremendous range made it possible to fly from Scandinavia over the North Pole to Alaska without any intermediate landing. In all twenty preparatory flights with the DC-6B and DC-7C were executed over the Polar area between 1953 and 1957. Some of them continued to Japan and even to Australia. These flights were made in order to check alternate airfields, radio aids, navigation facilities, weather in the Polar region, to train crews, and to test equipment. The range of the DC-7C aircraft was proved in the meantime by a SAS non-stop flight of 6005 miles on November 15, 1956, from California to Scandinavia in 21 hours 40 minutes; thus setting up a new official world distance record for commercial aircraft.

The travelling time between Copenhagen and Tokyo over the North Pole is 30 hours, against 50 hours via the southern route over India. The distance to Tokyo has been shortened from the previous 10,300 miles to 8000 miles. In 1959's programme the company will have three trips a week in each direction over the North Pole and two trips a week in each direction between Scandinavia and Japan via India. These flights have connexion in Tokyo, thereby providing regular commercial round-the-world flights in 80 travelling hours. A still shorter route to Tokyo would go over Siberia with a distance of only 5000 miles. A DC-7C and a DC-8 aircraft should be able to fly non-stop from Scandinavia to Japan on this route in 17 and 10 hours respectively.

An interesting question for many would perhaps be that of the price for such a round-the-world trip. A first-class ticket costs £662 8*s*. and a tourist-class ticket will cost £450. If we compare this to Phileas Fogg's* travel round the world in 1873 we will find that this trip cost him £20,000 and he took 80 days instead of 80 hours.

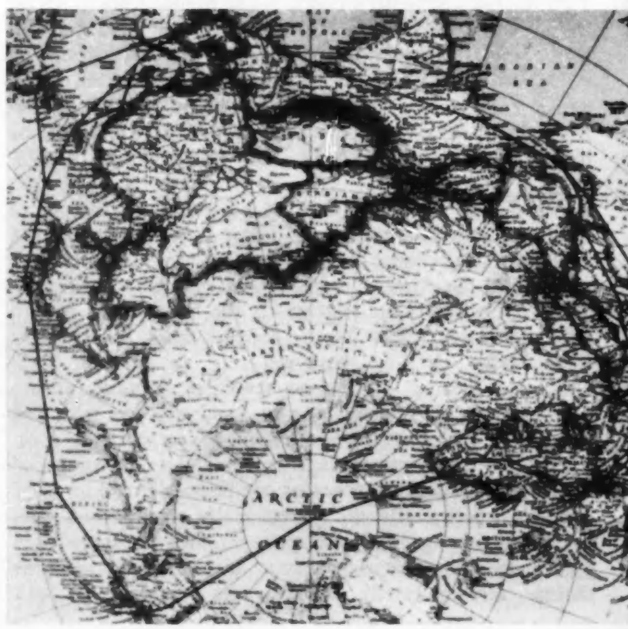
NAVIGATION PROBLEMS

Certain conditions which are peculiar to Arctic navigation have contributed considerably to the difficulty in developing trans-Polar air routes. Special problems affecting the magnetic compass and the lack of appropriate charts of the Polar area have necessitated the developing of new navigational methods, charts, and navigation equipment. This was the more essential in view of the poor coverage of radio and navigational aids then available which were, furthermore, adversely affected by magnetic storms and radio blackouts in the Arctic area, and also by the presence of the Aurora Borealis (Northern Lights).

One of the main difficulties of navigation in the Arctic is that associated with the convergence of the meridians and isogones (lines of equal magnetic variations). When flying close to the Geographical Poles, any heading will

* Jules Verne "Le Tour du Monde en 80 jours" Hetzel, Paris, 1873.

FIG. 3. SAS round-the-world route.

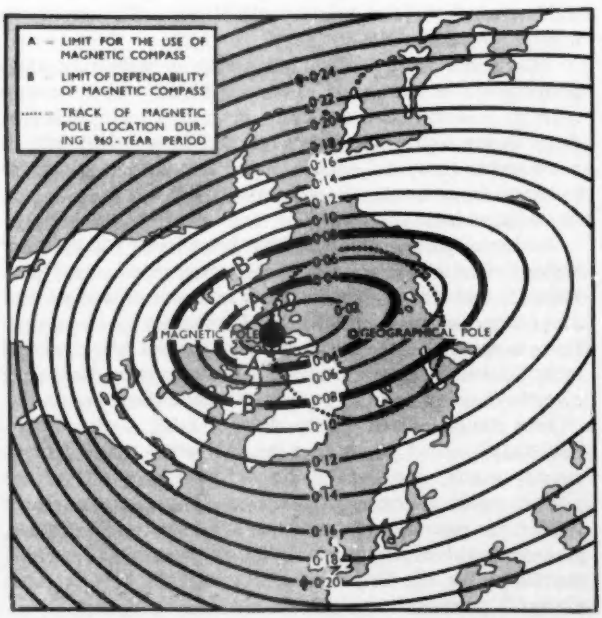


make the aircraft cut across a great number of meridians following quickly one upon another, at continually changing angles (the north-south course is obviously excepted). A short distance along the charted track will frequently involve a change of many degrees in longitude. If a trans-Polar flight is plotted on an ordinary chart one will find that it will follow varied headings: first, the aircraft is steered almost north; later, when passing by the North Pole, it is changed to a westerly course, and finally the heading is southerly. At 80° N the change in true heading is 1° per 10 nautical miles in east-west component, and at 88° N this change amounts to 5° per 10 nautical miles. As a matter of interest it may be mentioned that the duration of a flight from northern Scandinavia to Alaska is some 11 hours, which is the same as the difference in local time. Such a flight will therefore land at the same time as it took off.

GRID CHART

To overcome the inconvenience of changes in the true heading every time a meridian is crossed, a grid system was introduced. On a chart in Polar projection the Greenwich meridian is chosen as the standard meridian and a grid with one set of lines parallel to the standard meridian is superimposed on the chart. SAS uses a system in which the direction from Greenwich towards the North Pole and farther along the 180th meridian is defined as Grid North. When plotting a flight track in the vicinity of the Pole, all one has to do is to establish the angle of the track with the master meridian or one of the parallel grid meridians. The heading is then expressed in grid degrees and will remain the same all along the track. In this manner one becomes independent of the convergence of the meridians, and navigation is thereby considerably simplified.

FIG. 4. Horizontal component, in gauss, of the Earth's magnetic field.



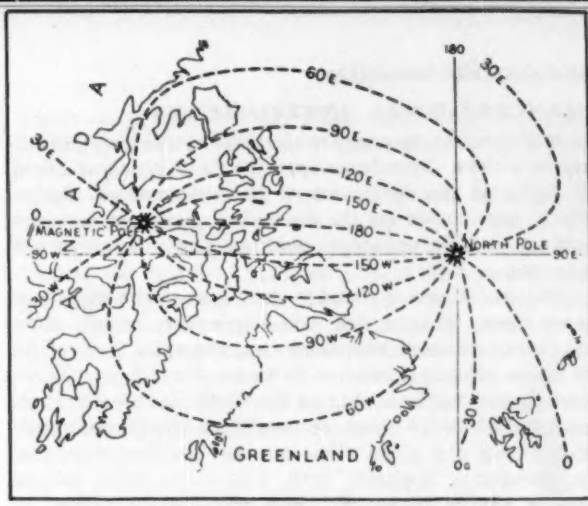
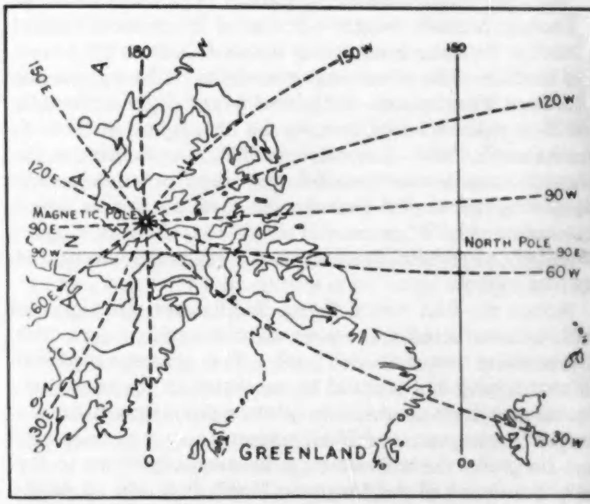


FIG. 5. (*Above*) Isogones with standard meridians.

FIG. 6. (*Below*) Isogrives with grid system.



GEOMAGNETIC NORTH POLE

Unlike the Geographical North Pole, the so-called Geomagnetic North Pole cannot be defined as an exact point, but may be described as the area within which the horizontal component of the Earth's magnetic force is zero, the entire magnetic field being vertical. A freely moving compass needle in this area will point towards the centre of the globe and its function as a directional instrument is of no use. The horizontal intensity of the Earth's magnetic field is considerably reduced within quite a large area around the magnetic pole involving limited dependability of the magnetic compass in the part of the Arctic region extending approximately from the south coast of Hudson Bay to the north coast of Siberia and from the north coast of Spitsbergen to the north coast of Alaska.

Another circumstance which makes magnetic steering impractical in the Arctic region is the fact that the deflection of the compass needle from true north is generally very large and varies rapidly with distance, as can be seen from the pattern of the isogones. They converge towards the Magnetic as well as the Geographical Pole. In the grid chart these lines are called isogrives and follow another pattern.

NAVIGATIONAL INSTRUMENTS

It is therefore necessary to use other course-giving instruments without dependence upon the Earth's magnetic field, if flights in the Arctic are to be performed as routine. These instruments are the directional gyros, the periscope sextant, and the periscopic polarised sky compass as well as radar.

The directional gyro takes the place of the magnet in some ways. Its rotor disc, which spins very rapidly about its gimbal-mounted horizontal axis, maintains its direction in space (that is, in relation to the fixed stars), in principle undisturbed for ever. But as the Earth also rotates about its axis 360° in 24 hours, the meridians change their angle to the rotor disc plane. This is to say, the directional gyro is subjected to "apparent" drift. This drift is called wander, and it has its maximum value at the Poles. Here the meridians intersect the Earth's axis at right-angles, where wander is 15° an hour. At the Equator, where the meridians run parallel to the Earth's axis, wander falls to zero, and between these two extremes it can be calculated from the formula: hourly drift equals 15° times the *sine* of the latitude. The directional gyro drifts to the right in the Northern Hemisphere. After two hours' flight at latitude 30°N, it will no longer indicate the heading set at take-off, for example, 360° or north, but 015°. In addition to the wander there is the so-called precession or random drift caused by mechanical disturbances, such as friction, which may amount to 10° an hour in an ordinary directional gyro. Wander and precession are the two components causing the drift of a gyro.

Before the SAS Arctic flights Bendix Aviation Corp. in U.S.A. constructed a low-precession directional gyro with a precession rate of about 1° only. This gyro was modified in such a way that it could be connected to the auto-pilot. In the usual set-up the auto-pilot receives signals from a magnetic compass, and if no connexion to a gyro system can be made, the aircraft must be manually flown in the neighbourhood of the Magnetic North Pole. In an emergency one could fall back on the ordinary directional gyros. The Bendix special gyro helped considerably during these flights, and the use of such low-precession gyros for navigation on regular routes in the Arctic is now essential.

If the precession or random drift of the gyro is small, flying on a constant gyro reading (in still air) in the Northern Hemisphere would result in a flight along the arc of a circle with an hourly change of heading towards the right equal to 15° times the *sine* of the latitude. The best way of correcting this tendency is to make a heading check every half-hour with astronomical observations, to compare this with the directional gyro reading, and to change the heading towards the left by the number of degrees corresponding to the drift since the last heading check. Thus, the track flown appears as a series of circle segments, and the distance becomes somewhat longer than the Great Circle distance between starting and landing points. The average track, however, coincides with the desired grid heading.

To avoid making the flight path a series of small circle segments the Bendix factory has introduced a latitude integration in the low-precession gyro. Thus, by means of a small wheel on the gyro the navigator may correct its rate of drift. Through calibrating the gyro to the latitude flown, the drift of the gyro may be reduced to very near zero.

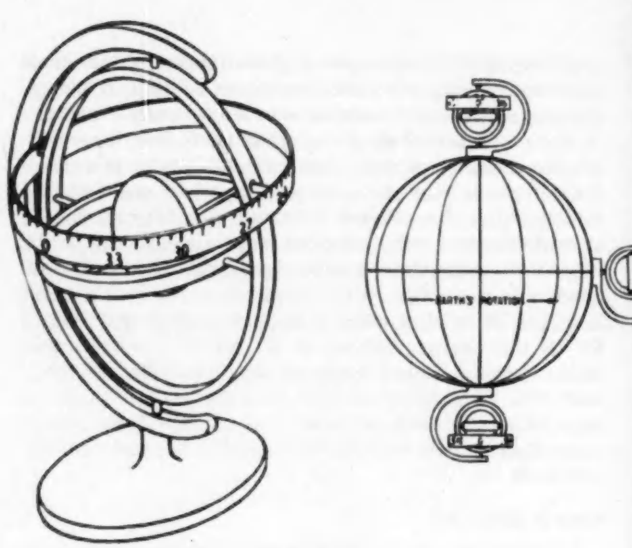


FIG. 7. The directional gyro with its rotor disc which spins rapidly about its gimbal-mounted horizontal axis.

However, the best navigational aid in the Arctic is still that based upon fixes of the stars. Conditions for celestial navigation are exceptionally good, especially in the winter months when the stars are visible 24 hours a day. In the summer months the Sun is continually above the horizon, and the Moon or the brighter planets may also be used when they are above the horizon. The difficult time for Arctic navigation comes around the spring and autumn when the twilight period is the longest. However, the periscopic polarised sky compass has been constructed for use in these twilight periods. It utilises the fact that light from the sky is polarised perpendicularly to the bearing of the Sun, and will give the bearing of the Sun even when it is below the horizon or hidden behind a cloud layer. The sky above must, however, be clear.

After astro navigation, radar is also an important navigational aid in the Arctic. Instead of being used for map reading, however, as is normally the case at lower latitudes, radar in the Arctic is employed to take lateral drifts due to wind and to compute ground speed. This is done with echo readings from outstanding objects which are followed on the radar screen.

As for radio aids, their use in Polar navigation is very limited. Radio ranges and beacons exist in Alaska, North Canada, and Greenland, but they are comparatively few and far between and are of little significance to navigation. Long-range aids such as Loran and Consol are available to a limited extent. However, the coverage is poor and disturbances due to magnetic storms make them unreliable.

Two navigators work together on SAS Arctic flights. One handles all chart work at the navigation table. He calculates winds, positions, drift, and speed, and gives the pilot the grid courses to be steered. The other navigator checks the gyro by means of the sky compass or sextant, makes a graph of the gyro's drift, and also shoots the stars, the Moon, or the Sun with his sextant, to calculate the aircraft's position.

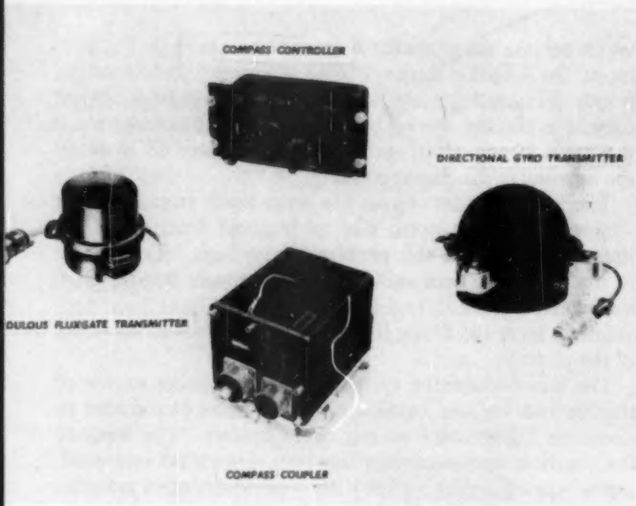


FIG. 8. The directional gyro with its accessories.

RADIO COMMUNICATIONS IN THE ARCTIC

The U.S. and Canadian Air Forces have established a comprehensive radio network in Northern Canada and Western Greenland. There are also several civil meteorological stations with radio equipment in this area. In spite of these facilities, radio communication is a difficult problem in the Arctic due to the frequency and intensity of magnetic storms. The visible counterpart of such storms is the Aurora Borealis display which is produced by the heavy bombardment of the ionosphere by solar storms. These magnetic storms may result in disturbances of the Earth's magnetic field which last from several hours to several days, causing more or less complete radio blackouts particularly affecting high-frequency transmissions; SAS has, however, taken all precautions to avoid this by building a network of large radio stations in this area. The Ionospheric Institute in Washington is normally able to forecast such magnetic storms well in advance although the intensity and duration of the storms cannot usually be predicted.

The severest radio disturbances do not occur at the Magnetic Pole but in a circular belt around it, known as the Aurora Zone. This belt passes very close to the whole north coast of Europe and Asia, dips down through Iceland and Alaska, and comes farthest south across Canada.

It is obvious that these conditions will also at times create difficulties in obtaining Arctic weather forecasts at departure stations of Polar flights. In order to ensure an adequate regularity of trans-Polar air services, an extension of the previous radio network in the Arctic regions has, therefore, been most desirable. Accordingly, a number of powerful radio stations have been installed at various points near the Aurora Zone. Five of them have ground-wave transmitters each with a range of at least 700 miles.

Direct teletype lines link some of the stations, such as Andenes and Copenhagen, Point Barrow and Anchorage. Further, Anchorage and Copenhagen are connected by teletype line via New York City. SAS Operations Centre in Copenhagen co-ordinates the continuous radio flight watch of aircraft over the Polar basin. Anchorage and Tokyo perform the flight watch of the route-leg between those two cities.

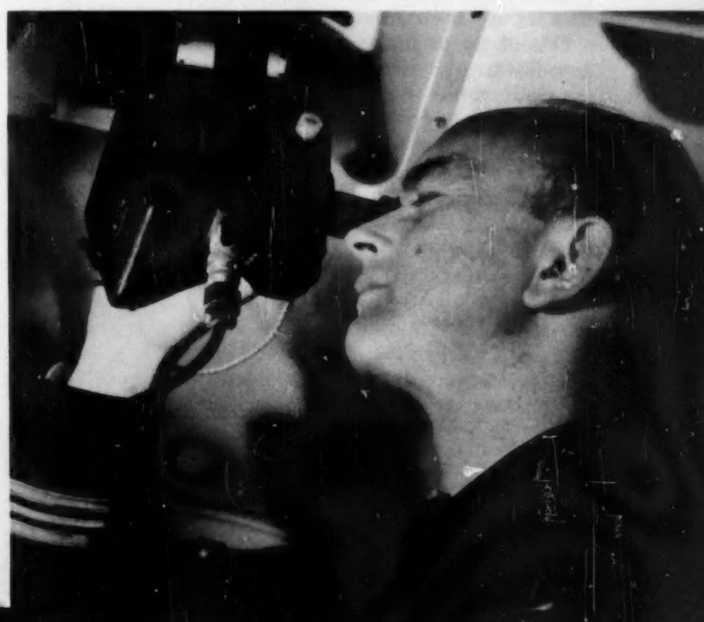
All these stations will feed weather and other ground data to the aircraft before and during flights. The aircraft in flight furnishes these Polar radio stations with position reports and uses the known location of the transmitters as a navigational cross-check. These powerful and expensive radio stations will ensure that the magnetic storms in the Polar area will not cause more difficulties for radio communications in the Arctic than elsewhere in the world. In over 900 flights which SAS has made on the route between Scandinavia and California no major disturbances have been experienced.

CLIMATIC CONDITIONS

When reviewing the history of Arctic aviation it is evident that the extreme climatic conditions have been the greatest obstacle to the development of trans-Polar operations, particularly in its early stages. This has been due not only to the technical problems associated with cold weather operations as such, but even more so indirectly to the difficulties of establishing the necessary ground facilities to make flying in the Arctic regions possible and safe. These adverse conditions were, of course, particularly hazardous when operating with the primitive aircraft equipment of bygone days, as was tragically evidenced by the many disasters of Arctic pioneering. Today, however, modern flying craft and navigational aids have so improved matters that the Arctic climate is no longer a major problem of trans-Polar operations.

In fact, flying weather in the Arctic is usually much better and more stable than, for example, in the North Atlantic area. Apart from the fact that low-flying haze, fog, and snowstorms may at times constitute a problem in connexion with take-off and landing operations, weather conditions are, generally speaking, better from a modern aviation point of view in the Arctic regions than in many other parts of the world. Turbulence is moderate and icing is not a problem in the cold but clear and dry atmosphere above the Arctic.

FIG. 9. The periscopic polarised sky compass.



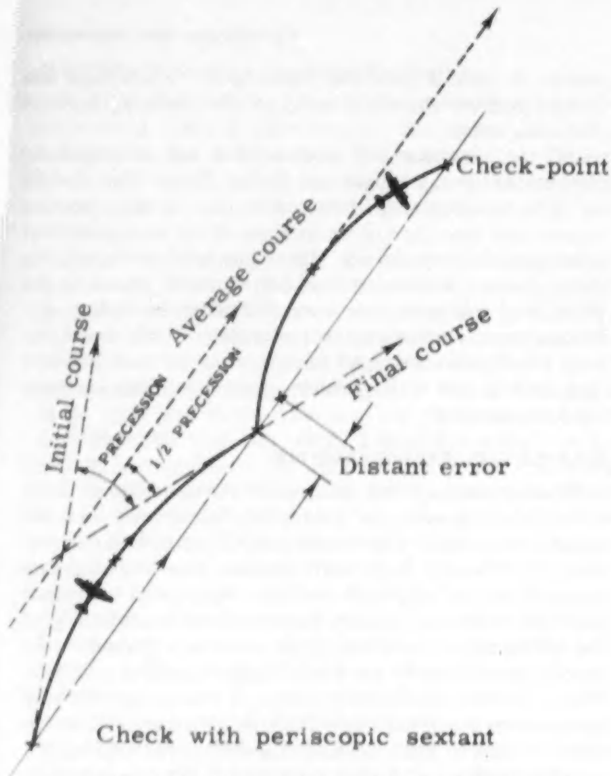


FIG. 10. Flying along arc of a circle. Flight with precession on a constant gyro course without automatic latitude integration.

COLD WEATHER OPERATION

The technical difficulties associated with trans-Polar operations are not primarily due to the low ambient air temperatures in flight. After all, they are not substantially lower than those quite frequently experienced over the North Atlantic in the winter. What makes the Polar route different are the extreme weather conditions encountered during ground stops in the Arctic area—particularly the combination of very low temperatures and strong winds. The main reason for the problems experienced is simply the fact that the aircraft are quite frequently subjected to the effect of extremely low temperatures for a considerable longer stretch of time when operating along the Polar route than is the case on other routes.

One of the problems experienced affected the propeller auto-feathering system which was sometimes found to react too slowly when checked before take-off. This was caused by a certain lag in the auto-feather switch at the BMEP transmitter on the engine nose-section due to the increased viscosity of cold oil in this part of the engine. A certain sluggishness in BMEP indications was also quite frequently noticed in flight under extreme cold weather conditions. To avoid these problems, the BMEP transmitters have been protected with insulating material.

The high viscosity of cold oil in the propeller system sometimes made it difficult to reverse the propeller during landing. In order to ensure positive and quick propeller reaction, the crews have been instructed to operate the propeller system by changing the r.p.m. a couple of times before landing. Also, several modifications have been made to the propeller system so that the circulation of warm oil into the propeller dome will be ensured. Furthermore, the propeller domes will be provided with permanent hoods of insulating material. To protect the engines against excessive cooling during ground stops, particularly when there is a strong wind, special shields are used to cover up the opening in the engine cowling.

The aircraft water system has given much trouble during winter Polar operations, due to frequent freezing of the lines. To eliminate this problem water lines located close to the skin have been moved (in some places flexible lines have been installed), and additional valves have been provided to leave the filling lines empty after ground servicing of the aircraft.

The air-conditioning system has been another source of trouble and various modifications are being introduced to eliminate "drop-outs" of the cabin heaters. The limit of the overheat thermo-switch has been somewhat increased, a new type of cycling switch with improved contact material has been installed, and the overhead fuses have been relocated so as to be accessible during flight. In addition, a plenum chamber has been incorporated in the combustion air intake to prevent snow and rain entering the cabin heater. So as to be able to operate the cabin heater on the ground while fuelling, special spark arresters are fitted to the cabin heater exhaust. Under extreme cold weather conditions it may be necessary to use a special ground heater to keep the cabin warm.

SEARCH AND RESCUE SERVICE

Canadian and U.S. military facilities provide the search and rescue service in the Arctic regions. It is very well organised and actually gives better coverage and security than is the case, for example, in the North Atlantic area. The availability of military airfields, which could be used in an emergency, is quite good. The SAS aircraft are never more than three hours flying from any landing base along the track over the Polar area.

In addition to the standard safety equipment carried on all overseas flights, such as life-jackets, rafts, distress signals, emergency rations, and emergency transmitter, SAS carries special Arctic safety equipment on the Polar routes. This includes snowshoes, snow-shovel, special petrol stoves, cooking-pans, mosquito nets, and warm clothing, such as fur-lined jackets, trousers, boots, and sleeping bags.

With the enormous amount of Arctic experience gained since the fatalities of early pioneering days, added to the availability of modern equipment and facilities, the outlook for rescue service is considerably more optimistic today. In fact it is probably fair to assume that an emergency landing on the snow-covered areas in the Arctic would turn out to be a much better proposition than ditching in the North Atlantic, particularly in consideration of the greater possibility of keeping dry. Military experience has shown that landings and take-offs can be made successfully with large aircraft without preparation in vast areas of the Polar region. It is imperative, however, that crews flying Polar routes have a sound knowledge of Arctic conditions and survival procedures. To this end SAS has arranged special winter courses in the mountains of northern Scandinavia, where various types of Arctic safety equipment have been tested and crews have been given an opportunity to build igloos, for example.

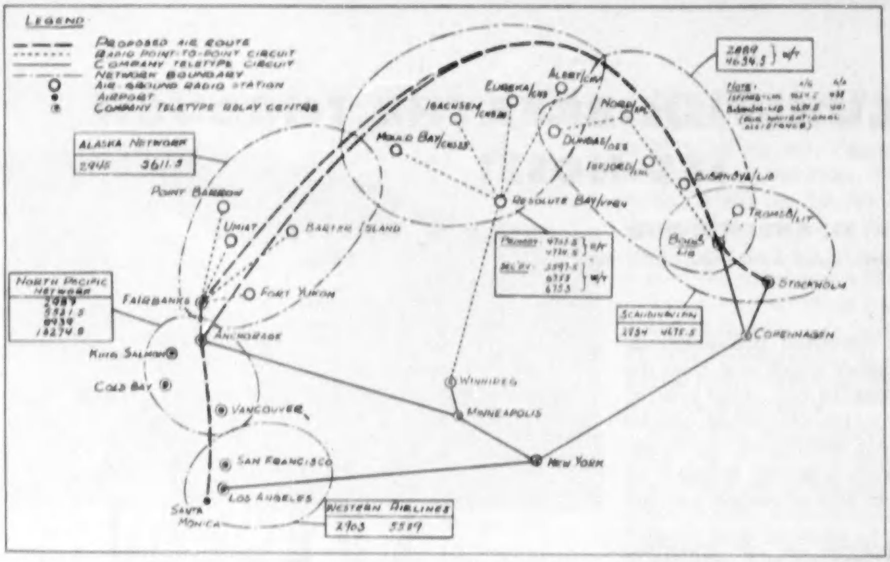


FIG. 11. Flight-watch. SAS radio communication system in the Arctic and its connexion to the teleprinter system.

NEW ARCTIC AND ANTARCTIC ROUTES

Undoubtedly the Arctic air space will become a very busy traffic area in the future. Already, thanks to the tremendous technical progress of aviation, the flights over this area are routine today, and it is no more remarkable to fly over the Polar region than to fly over any other part of the world, except that the evolution of such trans-Polar operations will always remain a fascinating part of aviation history.

The time has also now come to realise the fact that commercial flying across the Antarctic may soon become reality. During the next couple of years it will be technically possible to connect South Africa, Australia, and South America with direct routes by flying over the Antarctic continent. SAS will not have any interest in developing regular routes in the Antarctic area. Some time ago, however, the company seriously considered an application from a scientific foundation to have a SAS DC-7C outfitted as a flying laboratory with equipment mainly consisting of the same cosmic ray counters and electronic computer as used on the SAS scientific flight over the North Pole on February 16, 1957. The U.S. Navy had at that time built a very large temporary airfield on the sea-ice on the Antarctic coast in the McMurdo Sound with all modern airport equipment which would have been very useful for the flight. Unfortunately this charter flight over the South Pole had to be abolished after some considerable planning work.

The distance of some 6300 miles between New Zealand and South America over the South Pole is a bit too far for even a DC-7C, and a technical landing for refuelling somewhere in the Antarctic is necessary.

No doubt aircraft will be built which can make such a direct flight, or airfields will be built in the Antarctic thereby making it possible for large airlines in the Southern Hemisphere to develop commercial flying across the South Pole area. The traffic in this region, however, will probably not be as intensive as it will be over the Arctic.

The planning and preparation of the present two commercial Polar routes, which in all took some six years, will no doubt facilitate a speedy inauguration of new routes over both the Arctic and the Antarctic. This basic work is a tribute to the aviation world and a token of appreciation of the great Arctic pioneers, who during the last 400 years so gallantly and courageously fought the climatic conditions on the ground, the sea, and in the air, and gave the necessary information and foundation to the present routine commercial Polar flights.

(This article is based on a lecture delivered by the author to the Royal Aeronautical Society at Oxford on April 1, 1957.)

FIG. 12. Weather stations which are valuable for Arctic flying.

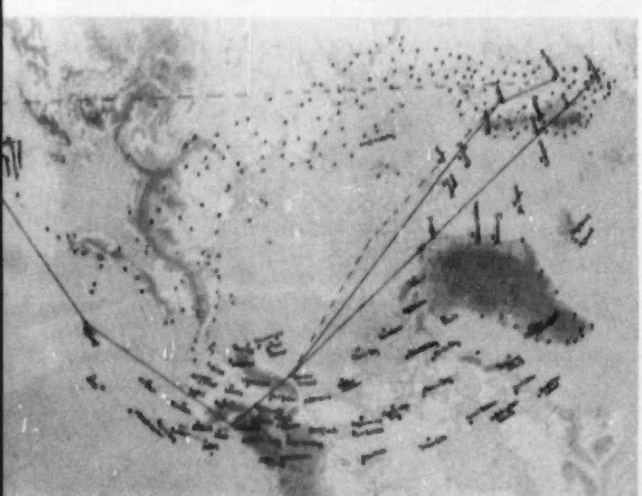


FIG. 13. DC-7C.

DOES A LUNGFISH BREATHE THROUGH ITS NOSE?

P. H. GREENWOOD
Department of Zoology, British Museum (Natural History)

O. OLIVA
Charles University, Prague

A characteristic feature of all terrestrial lung-breathing vertebrates is the pair of nasal canals which lead from the external nostrils, or nares, and open, by way of the internal nares, into the pharynx. With a very few exceptions, internal nostrils are absent in gill-breathing vertebrates, the fishes. In these animals, the nostrils provide a passage to and from the olfactory organs and are in no way connected with the respiratory organs.

It is known that internal nostrils are an important adjunct to pulmonary respiration and it is assumed that their evolution was an important step in the change-over from aquatic to aerial respiration.

Among the few fishes in which internal nares are present (see Atz, 1952) there is one group of particular interest. This is the Dipnoi or Lungfishes, which are at present restricted to the fresh waters of South America, Africa, and Australia. In earlier geological times the Lungfishes were widely distributed throughout the world.

Interest centres on the Dipnoi both because of their fossil history and because the modern representatives are able to breathe air by means of a well-developed lung (the Australian *Neoceratodus*) or paired lungs (the South American *Lepidosiren* and the African *Protopterus*). The fossil record suggests that the Dipnoi were related to the Rhipidistia (and Coelacanths), an extinct group of fishes from which the Amphibia and thus all land vertebrates were evolved (see Fig. 1). Since internal nostrils are usually associated with lung-breathing habits and because the Lungfishes are more or less dependent on their lungs for respiration, it was assumed that these fishes would also breathe through their nostrils. This idea was widely accepted despite the fact that no critical observations were made on living animals and also that in all extant Lungfishes the internal nares actually lie in front of the upper teeth and not, as in higher vertebrates, behind the palate. Furthermore, no really convincing arguments were put forward to explain why Lungfishes should be narial breathers.

In 1952, Atz published an account of breathing in Lungfishes and showed conclusively that the internal nares play no major part in the respiratory mechanism of these fishes. According to Atz, the nostrils of living Dipnoi, like those of other fishes, function mainly for directing water over the olfactory tissues.

Despite the publication of these direct observations, it is clear that, in certain quarters at least, the old notions about the function of internal nostrils in Lungfishes are still held. It is for this reason, as well as to add to Atz's account, that the accompanying photographs are published. Fig. 2 illustrates jaw and pharyngeal movements associated with aquatic respiration, while Fig. 3 shows the animal gulping air at the surface.

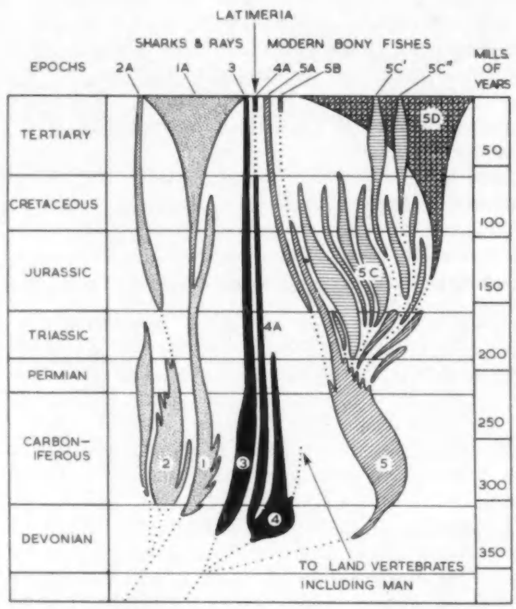


FIG. 1. Diagram of the history and relationships of the groups of fishes, based on an exhibit in the British Museum (Natural History). Groups 1 and 2 are cartilaginous fishes; groups 3 to 5 are bony fishes (Osteichthyes). (1) Selachii, persisting as modern sharks and rays (*1A*). (2) Bradyodonti, persisting as rabbit-fishes (Holocephali). (3) Dipoi, surviving as Lungfishes. (4) Rhipidistia, giving rise to coelacanths (*4A*) and to all the land-vertebrates. (5) Actinopterygii, the ancestral group of which persists as sturgeons (*5A*), and *Polypterus* (*5B*); in the mesozoic it gave rise to Holostei (*5C*) with two families surviving in North America, and one branch of the Holostei flourishes today as the Teleostei.

During the past two years one of us (O. O.) has been studying a species of African Lungfish (*Protopterus dolloi*) kept in aquaria. Observations on the accompanying photographs are summarised below, and are of particular interest because the breathing habits of this species, an inhabitant of the Congo River, have not been described elsewhere. Furthermore, this study has provided additional evidence for the disputed point: when breathing at the surface, do Lungfishes inhale through the nostrils, or, is air gulped into the lungs by way of the mouth?

Several stages in the respiratory cycle are shown in these photographs, the work of Mr Milan Chvojka of Prague. First the floor of the mouth and pharynx is distended and water is drawn into the bucco-pharyngeal cavity. Then, by contraction of the floor of the mouth and pharynx, water is expelled posteriorly through the openings of the gill chamber (the right opening appears as a pit immediately in front of the thread-like pectoral fin). These subaquatic movements of the mouth, pharynx, and gill-covers

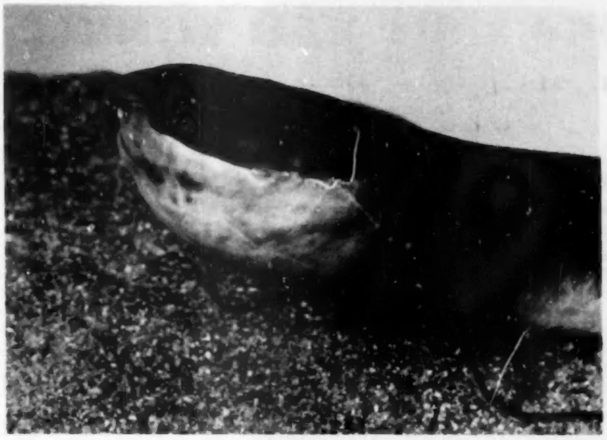


FIG. 2.

are performed at irregular intervals and usually precede an ascent to the surface (Fig. 2). Since the gills of *Protopterus* are greatly modified and reduced it seems probable that little respiration takes place through these organs.

The fish then begins to move towards the surface. The ascent is rapid and is carried out by strong, sinuous movements of the tail and posterior part of the body; the pectoral and pelvic fins make "walking" movements similar to those sometimes observed in swimming newts. During this phase there is an increase in the frequency with which the fish takes in water through the mouth and expels it through the openings of the gill-chamber.

After the snout breaks the surface, the mouth is opened wide; there is a short exhalation period and then the floor of the mouth and pharynx is greatly distended and slowly contracted as the fish "swallows" air into its lungs. Fig. 3 clearly shows the position of the external nostrils (*upper arrow*). The openings of the internal nostrils lie in the area of deep shadow and are not visible; the position of the left nostril is indicated by the lower arrow.

FIG. 3.

After remaining at the surface for a few seconds, the fish slowly sinks to the bottom of the tank; several small bubbles of air may escape from the gill-chamber as the fish moves downwards. There then follows a short period during which the fish can best be described as "yawning", the mouth is held open for a few seconds and then slowly shut; more bubbles of air may escape through the openings of the gill-chamber (Fig. 4).

The subject of these photographs, a *Protopterus dolloi* about 22 in. long, was kept in a tank containing 55 gallons of well-filtered water at a temperature of about 77°F. Under these conditions, the fish surfaced to breathe about once every half-hour.

Numerous field observations on the related. *P. aethiopicus* (by P. H. G.) confirm that Oliva and Atz have described a natural breathing cycle and not one only practised by fishes kept in aquaria. On hot, calm days in Lake Victoria large numbers of Lungfishes can be seen surfacing to breathe. The movements that follow surfacing are very

FIG. 4.

characteristic and differ somewhat from those described above. The fish remains with its snout protruded for some seconds and then flips the greater part of its tail clear of the surface as it plunges downwards. On the other hand, *P. aethiopicus* kept in aquaria or when guarding shallow nests, do not flip the tail out of the water. In these situations, post-respiration movements are essentially similar to those described by Oliva for a captive *P. dolloi*. Lest it be thought that *P. aethiopicus* only surface in calm weather, it should be stressed that even when the wind stirs the lake surface into a choppy sea, Lungfishes still breathe at the surface through their widely opened mouth, apparently without shipping any great amount of water.

REFERENCE

Atz, J. W., 1952, "Narial Breathing in Fishes and the Evolution of Internal Nares", *Quart. Rev. Biol.*, vol. 27, pp. 366–77.

REHABILITATING MEXICO'S RIP VAN WINKLE

IRENE NICHOLSON

In February 1958 we published an article on the work of the Mexican Federal Electricity Commission. The author has now visited the Papaloapan river basin south of Veracruz, also under the auspices of the Electricity Commission, although the work in this district is not limited to providing hydroelectric power. The Instituto Nacional Indigenista, which looks after the welfare of the more primitive Indian communities, and the Ministry of Hydraulic Resources, are also working there. Their corporate efforts are directed towards bringing 20th-century technology to an area whose inhabitants still live as they did at the time of the Spanish conquest of Mexico, five centuries ago.

TASKS OF THE PAPALOAPAN COMMISSION

"When science learns to understand human nature it will be able to bring happiness into our lives, a happiness which machines and the physical sciences have been unable to create."

This quotation from Bertrand Russell has been set by the Mexican anthropologist, Alfonso Villa Rojas, at the head of his study of the Indians in the Papaloapan river basin, and it has been kept healthily in mind by all workers in that area. The thrill of bringing modern implements to bear upon ancient problems has not been allowed to obscure the principal task: that of caring for about a million and a quarter primitive Indians.

Modern Mexico has two salient problems: humanly speaking, the adjustment of the poor Indian to modern techniques; and, physically, the control of its erratic water supplies. In most areas there is either too much water or too little.

The Papaloapan basin has always been subject to vast floods, with loss of property and life. As long ago as 1580 de Medina described how "when the river overflows its bed it floods everything, and the maize fields and the tubers, which are a kind of potato, are lost, and this is a common occurrence in most years".

A particularly bad flood took place in 1944. The "Papaloapan Commission" was then set up, and the resources of the Mexican Ministry of Hydraulic Resources, the Ministry of Health, the Indigenous Institute, and the Federal Electricity Commission were pooled:

(1) to regulate the constant inundations; (2) to provide controlled irrigation canals; (3) to bring agricultural methods up to date; (4) to provide sanitation; (5) to improve river navigation and road communications; (6) to generate electric power; and (7) to establish suitable industries.

Of these seven aims, the second has been entirely held up for lack of money, but work on all the others has proceeded more or less well.

FIG. 1. Old-style village in Papaloapan basin.
(All photographs are by courtesy of the Instituto Nacional Indigenista, Mexico)

FIG. 2. New village built by Papaloapan Commission.

GEOGRAPHY

The Papaloapan basin lies in the southern elbow of the Gulf of Mexico, the mouth of the river being at Puerto Alvarado, south of Veracruz. The discovery of this river by the Spaniards in 1518 is described by Bernal Díaz del Castillo in his "Discovery and Conquest of Mexico":

> "As we followed along the coast, the Captain Pedro de Alvarado went ahead with his ship and entered a river which the Indians call Papaloapan, and which we named the Río de Alvarado because Alvarado was the first to enter it. There, some Indian fishermen natives of a town called Tlacotalpa gave him some fish. . . . The General [Grijalva] was very angry with him for going up the river without permission, and ordered him never to go ahead of the other ships again, lest an accident befall. . . ."

Well might the General have feared for Alvarado's safety, in view of the belligerent reception the Spaniards had met with from the Indians all along the coast as they cruised south and west from Yucatan. When modern workers penetrated into the hills to survey the area, they were to meet with a suspicion and hostility which was in no way relieved by the fact that on this occasion the "invaders" were, like the Indians they came to visit, Mexican citizens.

The whole Papaloapan basin with its tributaries is nearly 18,000 square miles in area. It is larger than Holland, larger than Switzerland or Belgium, and well over twice the size of Wales. The area includes parts of three Mexican States: Puebla, Oaxaca, and Veracruz.

The River Papaloapan (over 300 miles in length, about half of which is navigable) is fed by six tributaries, two of which—the Santo Domingo and the Tonto—have caused most of the inundations, and also silting of the Papaloapan itself.

The coastal plain is broken abruptly by mountains which rise to nearly 19,000 ft. (peak of Orizaba), the average height of the land being about 6000 ft. In this territory the Indians have lived since the Conquest, as they did before it, in small, isolated communities, each with its own closely guarded customs. Nine different linguistic groups are represented, each with many different dialects, so that communication between villages is often difficult.

Rainfall varies greatly, in some parts of the basin being as low as 1 ft. per year, in others as high as 15. The vegetation thus varies from desert cactus to exuberant forest. The staple agricultural products have been sugar, rice, and cocoa on the plains, coffee on the slopes, with maize almost everywhere.

THE INDIANS AND THEIR CUSTOMS

Three different groups of Indians have been studied in this area, the most important being the *mazatecos.* They probably belong to the general group known as *chichimeca,* and are quite different from the Aztecs of the Valley of Mexico and the Mayas of Yucatan and farther south. Vestiges of the ancient culture known as "Olmec" have been found in these parts, but the word "Olmec" probably refers not so much to a particular tribe as to all those people who lived in the "land of rubber", the literal meaning of the word.[*]

The *mazateco* language contains four tones—high, semi-high, low, and semi-low—which give different meanings to the words. The language is said to sound like an accordion, an instrument of which the Indians are very fond. There is also a whistle-language, through which quite complicated transactions can be carried on without recourse to words.

The origin of these Indians is not known, but the *mazatecos* have a myth which tells that their ancestors were "upward-growing trees" rooted in "the land where men are born". Out of these trees came many kinds of creatures,

including monkeys, and also giants who became the eternal enemies of the *mazatecos*. There are similar myths in other parts of Mexico, including one from Oaxaca, which tells of two mountains divided by a gorge, through which a river flowed. This river, issuing from a deep cave, watered two large trees which gave birth to the first two chieftains, man and woman.

There is evidence that at the time of the Conquest, and for some generations afterwards, the *mazatecos* practised human sacrifice and cannibalism. Indeed, as recently as Lindbergh's flight across the Atlantic, two aviators made a forced landing in these mountains. They were never found, and it is supposed that they were massacred by the Indians. Although the hill-men have long been used to trading with "foreigners" who ply up and down the Papaloapan in small launches, they are still suspicious of strangers, even those who are dark-skinned like themselves.

As in most parts of Mexico, the ancient religions and customs are by now so mixed with Catholic ritual that it is no easy matter to sort out which is which. As the remote villages have usually no resident priest, the local headmen are able to retain their old customs unchecked. Thus many *mazatecos* still worship the spirits of hill, cave, and fountain, as well as "Father Thunder", "Father Sun", "Mother Moon", and malignant sprites known as *naguales*. At the foot of one mountain, *Rabón*, there is a cave where the local people gather to pray for abundant crops or relief from illness. The mountain itself is deeply revered because it is the home of supernatural forces and of magic beasts. At its summit there is said to be an enchanted lagoon in which live not only giants but even whales. At its centre there spins on the wind a seven-coloured gourd, origin of the rainbow.

The "Goddess of Fertility" is supposed to live in the sea on the eastern horizon. Her swollen breasts nourish the crops, and the sound of distant thunder is her voice singing a lullaby to the new shoots of corn. Early in June this goddess begins to shrink away, so that crops planted after that time will not flourish.

Deer are sacred animals, and when the maize begins to grow, an old man, possessed of mysterious powers, guards the crops, praying to the "God of Venison" that his children should not be allowed to trample over the fields. In order to appease him, birds are sacrificed over a fire, on to which shavings from the horns of deer have been cast, together with copal and banana leaves.

Only the more remote inhabitants of the basin, and those less in touch with the towns, hold these beliefs today. People are fairly sharply divided into "men of reason", who have been touched by modern influences, and the poorest peasants more purely devoted to their own customs.

Not only the religion, but even the calendar, becomes a mixture of old and new. The *mazatecos* still hold to their ancient count: eighteen months of twenty days each, plus the strange five days that are "nameless" and outside the calendar. This old calendar has long since lost the religious significance it must have had, and remains merely a convenient way of marking the agricultural seasons. As the ordinary Western calendar is also used and overlaps with the other, complicated adjustments have to be made from time to time.

Each village or municipality has its own form of government. Analysis of these shows that, though officials are often elected, the elections are by no means democratic, but are ruled by considerations of prestige and wealth.

Marriages and other ceremonies are subject to strict rules. A boy's parents choose his future bride, and then select a go-between to visit the girl's family. Before the wedding itself, the bride undergoes a ritual bath. After the wedding the newly married couple remain for a few days in the house of the girl's parents, and her husband must abstain from all sexual contact with her. When relations between them have settled to what is considered normal, the pair go to live in the house of the boy's parents until such time as he can afford one of his own.

During married life, certain periods of sexual abstinence are imposed, especially when the maize is being sown or when a relative dies.

Polygamy is practised, but not frequently. There is no formal divorce, and if one or other partner wishes to separate, he or she simply returns to the parental home. It does not matter whose fault the estrangement may be, the man always does his best to retain possession of the male children, and disputes on this score must sometimes be referred to law.

The late stages of childbirth are attended by witch-doctors, who pray to the gods, anointing the woman with special powders prepared from ground tobacco and chalk, to protect her from sorcery.

When anyone dies, the corpse is washed and dressed in clean clothes, this for material rather than spiritual purification. It is still customary to bury with the dead any possessions which he may want in the other life, including money for his journey. A mother, through some oversight, once omitted to include her child's favourite possessions in the coffin. She waited her chance to bury these with the corpse of a neighbour, whom she was sure would pass them on to her child in due course.

It is generally believed that the first four days after death are spent by the dead in visiting their earthly haunts and friends, to bid farewell. They then go on their journey, over a broad river, where a black dog waits to lead them to their final destination.

Witch-doctors are sharply differentiated from medicine-men and perform quite different functions. The business of the witch-doctor (male or female) is to protect from evil spirits and invoke good ones. Medicine-men are more in the nature of herbalists.

Not anyone can be a witch-doctor, but only those with special gifts, who are given the title "Lord [or Lady] of the Mountain". A witch-doctor is supposed to be able to avoid accidents and dangers to himself.

Witch-doctors work first by "listening to the blood". They try to divine the future, either with grains of maize or by eating narcotic mushrooms, which put them into a trance. If too many mushrooms are eaten—over six or seven—the witch-doctor will be ill and his patient will probably die.

When the cause of an illness has been determined, a magic "bundle" is prepared from *guacamaya* feathers, cocoa, eggs, bamboo, and paper made from a bark called *amate*. This "bundle" is buried near the sick person, who is ordered special abstinences. Something very like the modern method of "lie-detection" is used when the witch-doctor

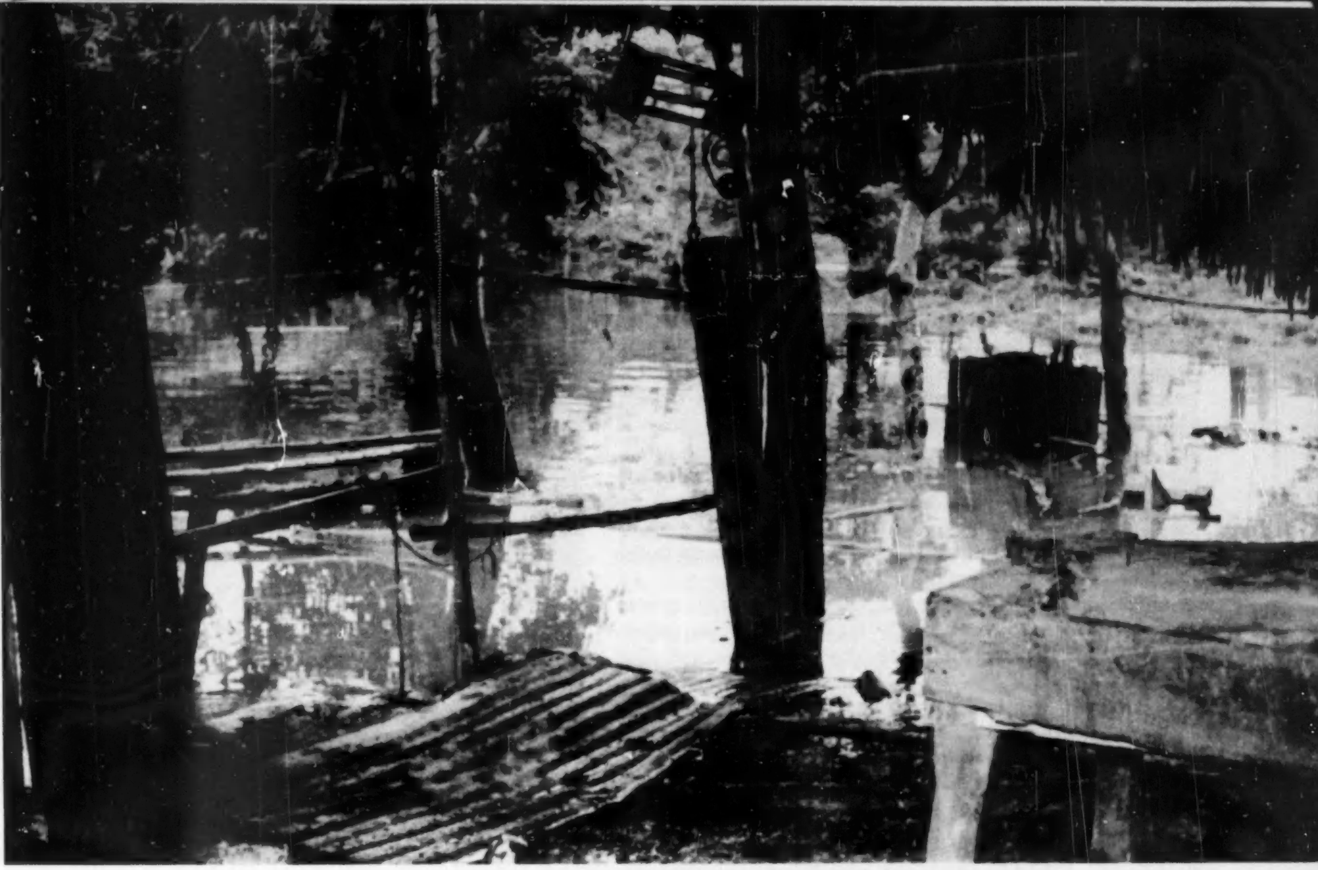
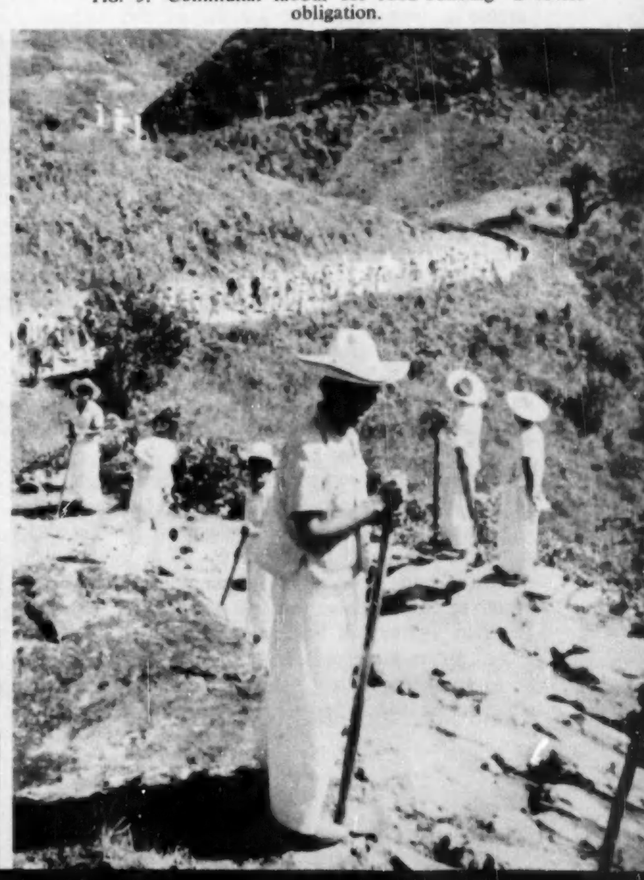


FIG. 3. Waters begin to flood a village on the reservoir floor.

FIG. 4. Inhabitants of a flooded village move out with their simple household belongings.

FIG. 5. Communal labour for road-building—a social obligation.



takes the patient's pulse, at the same time asking questions. Any lie will be recorded in a more rapid beat.

Medicine-men are not feared as witch-doctors are, for they can only cure evil, and not cause it. Medicine-men resort to cures by herbs and steam baths, with slapping and massage. Their initiation begins with the search for a special seed known as "Virgin's Seed", small and white, which must be blessed in the church, dried, ground, made into a potion, and drunk by the apprentice. (Sometimes the "Virgin's Seed" is replaced by mushrooms.) In a suitable subject, the seed should produce hallucinations, in which he is transported to heaven or—some say—to the "Eastern Cave". Here he has direct contact with "Our Lord", his apostles, and other saints. In heaven he holds converse with medicine-men of the past who instruct him in his art, showing him what is good and what is bad upon earth, so that he may form right judgment. He is also granted a vision of the place where witch-doctors go when they die, outside the precincts of the "kingdom of heaven".

All this has a relationship to modern research on *peyote* and *mezcaline*, which evidently transport men to supernormal states. The reports of Huxley and others, and also experiments in Mexico, show, however, that the wisdom thus revealed to men may become involuntarily mingled with valueless hallucinations and is therefore fraught with danger. It is not every modern worker who has, after taking these drugs, been able to "form right judgment" or discover the source of the magic lagoon and the rainbow!

ADVENT OF MODERN TECHNOLOGY

On to this primitive basis, where wisdom and superstition mingle in baffling promiscuity, is being imposed the superstructure of modern life.

The first task of the Papaloapan Commission was to create a vast reservoir, known as the Miguel Alemán (which is confusing for foreigners, who are unaware of the propensity of Mexican presidents for perpetuating their names). The reservoir, which actually encircles several hills so that at present there are islands rising anything from 100 to 600 ft. above the water-level, has an area of nearly 118,000 acres, and a capacity of about 8000 million cu. m.; 970 million cu. m. of flood-water can be held in check. When the hydroelectric plant is completed it will generate 744 million kWh per year; and it will eventually be possible to irrigate about 173,000 acres of land. The catchment for the reservoir is over 1300 square miles, and when full the lake is about 20 miles long, its greatest width being about 9 miles. This represents roughly the area from the centre of London to Windsor, and from the Thames at Westminster to Edmonton, or, say, the length of the estuary of the Firth of Forth from Edinburgh to the sea, with the width of the Forth at Edinburgh.

This lake has been created by building a number of dams at various widely separated points in the mountains. One of these is across the Río Tonto itself. It is a sluice dam, approximately 250 ft. across by 30 ft. high, with eleven separate gates to control the immense tonnage of water which at present flows through several open sluices, to keep the Río Tonto full but controlled from flooding. "Silly river", the name means, but the engineer says it is far from being so. Immediately below the dam, for a mile or more, white heron and widgeon have their breeding-grounds. The

FIG. 6. (*Above*) Mother and daughter in typical patterned dresses, removing corn husks.

FIG. 7. (*Below*) Primitive method of shelling coffee.

trees and rocks are thick with thousands of these graceful birds, so unused to people that they scarcely trouble to move even at the spluttering of a car on the loose gravel. Shooting and hunting are forbidden in this bird sanctuary, where the ocelot (American tiger) also roams.

About 5 miles away, on the other side of a forested peak, is the main dam wall, above the village of Temazcal, where the hydroelectric plant is being constructed. This dam is about 900 ft. long and 80 ft. high at its maximum. It is built of rock and rubble with concrete facing, 5,465,000 cu. m. of material having been used, of which over 4,000,000 is rock and 131,000 concrete.

At one end of this dam wall the electric plant is being set up. The turbines are Escher-Wyss (Swiss) and the generators Siemens (German). The plant will provide electricity for the State of Veracruz, including the ports of Tampico and Veracruz. Pylons may also eventually straddle the watershed to the small but important town of Oaxaca, capital of the State of that name.

The dam wall extends on, beyond a natural rock barrier, into a lower dyke, about 2300 ft. long and about 38 ft. high. From the far end of this it is hoped to build an irrigation canal which will water the land below. Fifty miles of concrete-faced canal are projected.

Two other auxiliary dykes have had to be built in the hills to the south and south-east.

Seven cuts in the river have been made, covering a distance of 6570 m. and requiring the removal of 1,500,000 cu. m. of earth. The distance by river between Tuxtepec, an important town, and Alvarado has been reduced by 196 km.

Also, asphalt facings have been built along the Papaloapan, raising the river-banks by about 2 m. Dredging is projected but has not yet begun.

REHABILITATING THE INDIANS

About 20,000 mazatecan Indians had to be moved from the floor of the reservoir, and the problem was not simply of rehousing but of psychological adjustment. The people of the broad plain between mountains and coast are very different from the hill Indians, and their blood has been mixed with the negroid to form what are known as *jarochos, mestizos* who are in temperament livelier, quicker to respond outwardly to pain or pleasure, than the pure Indians. The Indians of the hills suspect them as being quarrelsome and inclined to theft, whereas the plainsmen in their turn regard the hill Indians as ignorant, lazy, and easily taken in. Great tact had therefore to be exercised wherever it became necessary to make neighbours of these mutually suspicious factions.

Moreover, even among the hill Indians themselves, it was politic not to mix the people from different municipalities. It became more important to find land which would accommodate a whole township without splitting it, than to procure the best land for agricultural development. Inter-state politics entered too, because many Indians formerly resident in Oaxaca had to be moved to Veracruz, with consequent complaints from the Government of the former because of loss of manpower.

It was a dramatic moment when the water began to flood the reservoir and the peasants had to move. The wife of each family, the last to leave the house, closed and barred

FIG. 8. The Mazatecan Indians are fond of music.

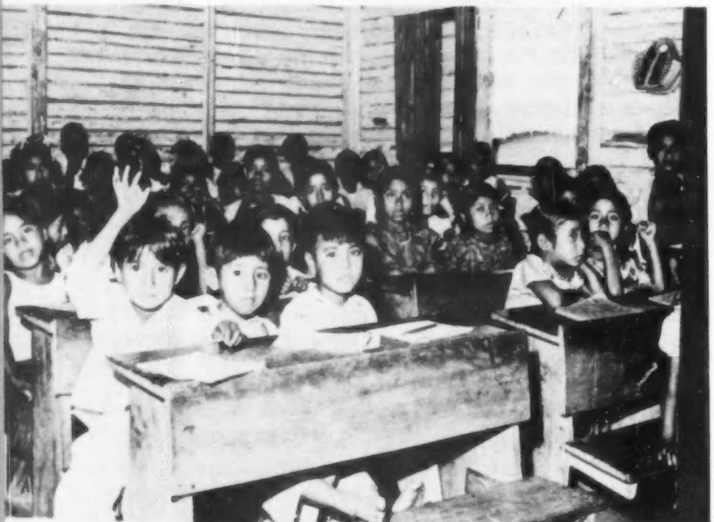


FIG. 9. One of the new Government schools.

FIG. 10. Sluice gates of reservoir.

the doors so that animals would not enter. Even at this moment they hoped one day to be able to return and find their homes intact.

Certain conditions were laid down by the Government for their removal:

1. Transport would be provided. 2. Free transport would also be provided for families to visit the sites of their old homes whenever they wished. 3. On arrival at their new home, each family would receive 100 kilos of maize. 4. Every man over sixteen would receive 5 pesos a day until the first crops were gathered from the new land. 5. Each family would be given a house, with 1400 sq. m. of land planted with fruit-trees. 6. Every man over sixteen would be given 10 hectares for cultivation and 5 more in reserve. 7. If any peasant had previously more valuable land and house, the difference would be made up.

There have been complaints that some of these conditions have not been fulfilled, but it has been impossible to get exact data.

During the process of selecting new land, some of the more enlightened *mazatecos* were brought in as advisers, and they inspected the new ground with the utmost care and attention. It was difficult to convince them that land which was at this time arid would later, owing to the new reservoir and irrigation, become the most fertile. They picked up the earth, crumbled it to observe its texture, and critically studied the local inhabitants who were to be their neighbours.

Over this policy of using local advisers there was some dispute with the Central Mexican Government, but luckily the men on the spot won their case against bureaucratic interference by men who had no knowledge of or contact with the Indians.

Land having been selected, the next task was to house the Indians. It had been hoped to build homes less conducive to promiscuous habits than the old ones, and also to use imported and more adequate materials than the local palm roof and logs. Considerations of time and cost made this impossible, but at least the new houses have cement instead of earthen floors; and there are two bedrooms, with a front corridor serving both as kitchen and eating quarters. Sanitary latrines have also been provided.

CARE OF HEALTH

The health of the Indians was the next care, and here ancient superstitions had to be fought. Even certain elements in present-day political parties created serious obstacles. The story was spread that the secret purpose of vaccination was to sterilise and so put an end to this "lazy and ugly race".

One doctor said that it was depressing, when he wanted to spend his time on preventive medicine, to have to direct most of it to curing the sick. The chief scourge is malaria. This doctor considers it impossible to attack the malaria mosquito direct—though certainly the draining of swamps will help. He thinks the best method is prophylaxis with Paludrine, but funds are inadequate. There is difficulty, too, in inducing the Indians to take the pills, which are often discovered later lying on rubbish-heaps.

Anaemia is rife, also all forms of dysentery, helminthiasis, onchocerciasis, vitamin deficiency, hypoproteinaemia, and pinta—a scourge because of its resulting skin blemishes

with consequent social implications. Incidentally, *Treponema herrejoni*, the virus of pinta, is named after its Mexican discoverer, González Herrejón.

Onchocerciasis, caused by *Onchocerca volvulus*, attacks eyes, so that it is no uncommon sight to see bands of blind peasants roped together, guiding one another along the roads.

In the past the diet has consisted almost wholly of maize, beans, red pepper, and pumpkin. Even if the peasants possess cows, they are disinclined to drink milk or eat cheese, and some even give all the milk to their dogs. A popular drink is *pinole* prepared with aniseed, cocoa, cinnamon, sugar, and a root called *cocolmecatl*. The drink is beaten to a froth, and, as may be imagined, is tasty and nourishing. Another drink, *posole*, is prepared with maize flour used either fresh or sour; in the latter case the dough is left to stand several days, and may be used for cultivating mushrooms.

Breakfast consists usually of sweetened coffee with tortillas (maize pancakes) and a slice of yucca or pumpkin. At lunch the peasant will eat boiled beans, tortillas with chilli sauce, garlic, and tomato. The same meal is repeated at night, with coffee added. Variety is introduced by a species of non-poisonous nightshade known as *yerba mora*. Maize is the staple, and a family of five will eat on an average thirty-five corn-cobs a day. Only on feast days a hen may be killed.

The protein intake is low, and there is also deficiency of riboflavine, niacine, and certain vitamins. An effort has been made to introduce soya flour, which can be mixed with maize, and to educate the peasants in the use of milk, cheese, and wheat flour. Meat and fish are slowly being added to the diet.

The most popular alcoholic drink is rum, although beer is now taken by the younger generation, and there is also the local brandy known as *aguardiente*.

EDUCATION

Some of the Indians have been so keen to learn that before the State schools were established they built their own and paid the teachers' salaries from their private money. Before the Commission began its work, there were only five schools in a town of over 16 000 people; but some of the local students who have passed their examinations are now teaching in the thirty-two Government schools.

Visual aids (film strips, films, diagrams, etc.) are used extensively in education, which is directed at present chiefly to the three R's and to health and hygiene.

RESULTS

Before the Commission began its work the main wealth was in sugar and coffee. The crops were bought in advance according to prices fixed by the local merchants. There was no way by which the peasants could get higher prices, because there were no other people to whom to sell. Now that the Commission has stepped in, not only are injustices of this kind being dealt with, but the crops themselves are improving. A hybrid maize known as "Papaloapan I" has been introduced, which is capable of producing 3½ tons per hectare. The production of rice, sesame, beans, sugar-cane, and vegetables has also been raised.

It has always been the custom among these peasants to

FIG. 11. At work in a Government clinic.

form gangs for communal work, such as road clearing, bridge building, and so forth. On market days the headmen of the village will stand and exhort the men to help with such tasks. These orations perform a similar function to those of Churchill and Roosevelt during the war, the object being to inculcate a spirit of public service.

Apart from these exhortations, a custom known as *tequio* demands a certain quota of work from each Indian as a tribute to the community. Sometimes as many as a thousand men gather for these general tasks. The institution has no legal support and is simply a moral obligation, but its use has made the task of reconstruction easier, for the Indians have readily given time to carpentry, building, digging, and work is going on apace. Any money the Mexican Government or foreign investors care to put into this area will produce ample returns, for the Indians have shown themselves quick to learn and relatively adaptable. The original scheme turned out to be in some respects more than the finances available could meet, and it is sad to see certain of the work stagnant. But a beginning has been made and the enterprise will surely continue.

The author's thanks are due not only to the official bodies mentioned, especially to the Federal Electricity Commission, but also to the following people on the spot: Ings Hector Valverde and Humberto Falero, in charge of the hydroelectric station; Ing. Oscar Mendez Rojas of the Ministry of Hydraulic Resources; the two anthropologists in charge of the local branch of the Indigenous Institute—Raúl Rodríguez and Agustín Romano; and the doctor, Raúl Novelo Echanova. Material has also been gathered from "Los Mazatecos y el Problema Indigena de la Cuenca del Papaloapan", by Alfonso Villa Rojas, published by the Instituto Nacional Indigenista, Mexico, 1955.

PRESENTING SCIENCE TO THE PUBLIC

MAURICE GOLDSMITH

At last—a scientific report on how the popular presentation of science affects people. For years science writers have been at the mercy of the ignorant and the illiterate, in terms of science education, whose assessment of the public want for science news has been completely subjective.

Now we have a basis for reasoned protest, although care must be taken as it is an American report and we cannot argue from the American scene to conditions here. But "The Public Impact of Science in the Mass Media"* contains much of value to us. This report was sponsored by the National Association of Science Writers and supported by a grant from the Rockefeller Foundation. The research was conducted by the Survey Research Centre of the Institute for Social Research of the University of Michigan.

The report begins:

> "The scientific journals of the world pour forth research papers at a rate of twenty thousand a week. The science writer, as the middle man in the flow of communications, must select, condense and translate from this fantastic deluge of information those items he is to transmit to the lay audiences of the mass media.
>
> "In economic terms, it is not supply but demand that is the problem in the transaction. More precisely, it is the demand that has been the unknown factor in the decision to market more or less of the science news commodity. Because demand has hitherto only been guessed at, other factors—some objective, like space limitations and financial considerations, some subjective, like an editor's feeling for 'what people really want'—have played the major role in determining how much science has been presented in the mass media."

The study assesses the demand side of the equation—measures the size of the science audiences of the major media, and points out some of the factors which contribute to the consumption of science news.

The first fact to emerge is that the amount of science in the mass media in the U.S.A. is infinitesimal in comparison to the volume of "raw" science information. In 1955 science news made up less than 5% of the space in a sample of twenty-six dailies. This was, if anything, a very slight increase over the period 1939–51.

Secondly, the number of science news consumers is much larger than one would infer from the proportion of media content devoted to science. Returning to economic analogy: demand seems to have been drastically underestimated. And this special study was made before the first *Sputnik* intensified the Soviet-American science race.

Science was defined as follows:

> "It includes everything scientists discover about Nature—it could be the discoveries about the stars, or atoms, about the human body or the mind—any basic discovery about how things work and why. But science also includes the way in which this information is used for practical purposes—it might be a new way of curing a disease, or the invention of a new auto engine, or making a new fertiliser."

Some of the findings of the survey are given below. They are taken directly from the Report and are only slightly edited by the present author.

1. *What is the size and consumption of the major mass media audiences?*

The mass media, singly or jointly, cover all but 1% of the private dwelling units in the sample. Half the sample falls in the overlapping audiences of all four mass media. The use of multiple media increases with education and income. Newspapers cover nine out of ten people, television almost as many, radio about four out of five, and the magazines about two-thirds. The greatest change in the media pictures during the last decade has been the rapid spread of television. Radio appears to have lost ground to television, but the written media have held their audiences well.

Most people name the papers as their primary source of general news, and television as their main source of entertainment. Television has apparently made inroads in the radio audience in everything except news and music. For newspapers, magazines, and television, the non-users are characterised chiefly by low income and low education. Radio, in contrast, has overcome these two barriers and is the most evenly distributed of the media. Radio and television cover most of the people the newspapers miss.

In short, the mass media of communication touch almost everyone.

2. *What is the size and characteristics of the science audiences of the media?*

Newspapers are the major primary and a strong supplementary source of science news for the public. The reading of non-medical science news is associated with a cosmopolitan and rather intellectual approach towards news-content. The reading of medical news, on the other hand, tends to be associated with a more personalised, local point of view. This reflects, in some degree, the fact that men tend to read more science and women more medical news. The sex differences show up at all levels of education.

Education and income are positively related to science news reading of both types. Whether measured by reports of extent of science reading, or by recalling actual science items, income and education are related to attention to science news. Most of the non-medical science recalled is of an applied nature and the medical news centres around a few major diseases.

Evaluations of science news rate newspapers on the positive side of the scale, but qualifications about the perceived accuracy indicate that science in the papers is not entirely trusted. Although most of the newspaper readers who recall science also recall it from other media, the radio is the least often mentioned source.

The newspaper audience, which includes nine out of ten adults, carries the greatest load in transmitting science information. Furthermore, even in the social categories least prone to read science news, a sizeable minority is reached by the paper's presentation of science. This finding is perhaps the most important one of all, for it demonstrates that science news is not read solely by the élite. Two percentages summarise the power of the paper to transmit science news to an unusually broad audience: 71% of newspaper readers can recall some type of science story read recently, and this is equivalent to 64% of the nation's adults.

3. *What is the content of science news which has been read, heard, and seen?*

About one out of every three in the magazine audience recall science items and about the same proportion recall medical stories. Science readers are most likely to be men while medical readers tend to be women. Education and income play a strong role in relation to recall from magazines. The magazine audience tends to be a relatively élite audience compared to the other media. In general, the magazine readers of science are highly satisfied with the way their medium presents science. In terms

* "Science, the News, and the Public", by H. Krieghbaum, New York University Press, 1958.

of supplementary media, the newspaper plays the largest supporting role.

The radio audience of science is small; only one out of ten listeners can recall items they have heard. In terms of social characteristics, the science audience is unique in that it is spread very evenly throughout the population. Although reactions to science on the radio are generally favourable, the radio group derives a great deal of supplementary science information from the papers. This is presumably because the radio is the poorest medium for science, completeness and accuracy being its weakest points.

About one out of four television viewers recall science and medical items. Education and income are the social factors most strongly related to recalling science and medical items from television. Science recall is greatest among the younger age brackets. Evaluations of science on television are very positive. Science fiction is strong on television and there is some confusion between it and legitimate science. Dramatic presentations of science have had the greatest impact.

In general, magazines, radio, and television are the sources of less science and medicine for the adult population than the newspapers. Most of the content of the recalled stories centres round technology and the major diseases. From the data it appears that the magazine audience is somewhat more select than those of the other media. Television, which has unexplored potentialities for science news transmission, does not yet challenge the lead of the newspapers in this area.

4. *What are the social and psychological factors that relate to the consumption of science news?*

Attention to science news is the product of a complex process. No single motivational factor can account for the behaviour. Certain general themes, however, may be traced in the data which shed light on the question of motivation. A good-sized proportion of adults are anxious to have more science and medical news available to them. Of the newspaper audience, 30% want more science, and 46% want more medical news.

There is a widespread positive motivation regarding science news. About one-quarter of the sample may be called science enthusiasts—they are already consumers of science and want more. Over half the sample is actively oriented to science news. Only three out of twenty are apathetic about science. The "science-prone" groups are found at every social level.

A majority would be willing to have other news deleted to get more science in the papers. Two out of three suggest items that might be taken out; however, most of the items named are those in which the person is probably not interested, or of which he disapproves.

The reasons for interest in science most often cited are of a fairly broad nature. The desire to "keep up with things" and the theme of science and survival stand out. Specific reasons, such as intellectual curiosity or strictly utilitarian concerns, play a less prominent role. Orientation to science seems to serve the broader functions of making sense of the world and helping manage one's relations to it. The practical implication of this generalisation for the science writer is to present science in its context, whether the topic be abstract or concrete, and not to present bits and chunks of facts in isolation.

5. *What are the conceptions and attitudes of the public relating to science and scientists?*

When asked to strike a balance of the effects of science on the world, the public overwhelmingly stresses the good effects. They are seen primarily as improvements in health, standard of living, and technological advance. The direct bad effects on the world are seen almost entirely in terms of the destructive potential of atomic energy. However, scientists are not blamed for the direct bad effects to any large extent; responsibility is not focused on any one group, but is scattered and the attributions are vague.

The secondary, or indirect bad effects concern the impact of science on the social order. Substantial minorities see science as making things change too fast, undermining moral beliefs, and creating the possibility for manipulation of human beings. Those people who are highly concerned about these issues are more likely to suggest limits on scientific research. In general, people believe the endeavour called science is a matter of thorough analytical approach to a topic or problem. No particular emphasis is placed on the criteria of science for valid and reliable knowledge.

Belief that science can tackle any kind of problem is widespread, though some have reservations as to the study of man. And the success of science in understanding the world is generally agreed upon. However, there is a dissenting minority with respect to each of these areas. Substantial minorities also feel that science should focus exclusively on practical problems and should avoid possible clashes with religious beliefs by restricting research in controversial areas.

The scientist himself is seen as an intelligent, educated, hard-working, dedicated person. A small minority sees more negative traits, such as social ineptitude or eccentricity. The negative undertones in the image of the scientist, revealed by specific questions, involve the beliefs that scientists are prying, odd, and irreligious. The minority holding these attitudes is also willing to impose limits on research freedom.

The relationship of the attitudes towards science and scientists with attention to science news, reveals that positive attitudes are associated with more extensive reading. The perception of the universe as orderly and knowable also goes along with attention to science. The perception of the social world as controllable and benign is associated with a positive orientation to science.

In brief, the general orientation to science and to the world bears on the question of communication behaviour. The image of science and scientists has a very positive tone. However, concern about the bad, indirect effects of science and the digressive traits of scientists is an underlying theme. In periods of crisis it is possible that these ambivalent attitudes could lead to a more negative picture of science. The possibility of scapegoating of scientists or the advocacy of research restrictions are potential consequences of the mixed attitudes. For the present, however, science is seen as a "good" endeavour, and scientists are seen as dedicated to "good" ends.

From "The Mental Health Aspects of the Peaceful Uses of Atomic Energy", prepared by a Study Group of the World Health Organisation, some comparative figures can be obtained for the United Kingdom. An attempt was made by the Study Group to estimate coverage of nuclear energy in its various forms in three daily British papers:

Over a ten-year period, 1947–57, in a "popular illustrated daily, of mass circulation, catering for a lower educational group", the average coverage each year was roughly one news story every ten days and one feature article every three months. That is about forty words per issue.

During the six-month period ended April 1957, "a daily paper of quasi-popular type, but with a particular concern for social affairs" devoted 600–700 words per issue to atomic energy matters, that is just under 1% of its total column space.

During the first five months of 1957, "a daily paper of more restricted circulation, catering for the higher educational groups in an area which happens to be particularly rich in atomic energy projects", devoted nearly 2% of its column space, that is about 1500 words per issue.

A survey along the lines of the American one is needed in this country. The Association of British Science Writers might consider finding a sponsor. There is no reason to believe that the general picture would be very different from that in the U.S.A.

THE EIGHTH GENERAL ASSEMBLY OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

Prof. A. V. HILL, F.R.S.

Secretary-General of ICSU 1952–5

The General Assembly was held at Washington, D.C., in the rooms of the National Academy of Sciences, last October. It was preceded by meetings of the Bureau and of the Executive Board, and followed by a final meeting of the Bureau. Present were representatives of thirteen International Unions (the "Scientific Members") and of twenty-nine countries (the "National Members"); together (by invitation) with representatives of Special Committees and other organs of ICSU, and observers from UNESCO, and other international organisations.

The general impression formed was that ICSU has now emerged from its earlier experimental stage and found its feet as a competent and efficient organisation, capable of undertaking important international scientific tasks with wide general agreement and rather little faction. Its administrative secretariat is established at the Palais Noordeinde, The Hague, under excellent conditions provided by the Royal Netherlands Academy and the Netherlands Government. The great success of the International Geophysical Year has encouraged the initiation of two rather similar enterprises, for Oceanic Research and for Antarctic Research. The ICSU Abstracting Board has done such an excellent job in physics, and more recently in chemistry, that the expansion of its work to include biology has been authorised (this will be a very big enterprise). The Federation of Astronomical and Geophysical Services (FAGS) (designed to receive, to analyse, and to synthesise astronomical and geophysical observations, and to make the results generally available) is now fully established. All this is complementary to the traditional objects of ICSU, particularly that of aiding the activities of the International Scientific Unions.

The following are some of the decisions taken by the General Assembly:

(1) **IGY.** To set up a Special Committee for Inter-Union Co-operation in Geophysics (SCG), whose primary task will be to deal with all aspects of the closing of the IGY enterprise. It will start to function on July 1, 1959.

(2) **SCOR.** To establish a Special Committee on Oceanic Research. This is charged with furthering and co-ordinating scientific activity in all branches of oceanic research, biological as well as physical.

(3) **SCAR.** To establish a Special Committee on Antarctic Research. This is charged with furthering and co-ordinating scientific activity in Antarctica.

(4) **IWDS.** To establish an International Service for World Days.

(5) **COSPAR.** To set up an ICSU Committee on Space Research, to function until the end of 1959. Its primary objective will be "the maximum development of space research programmes by the international community of scientists working through ICSU and its adhering Members".

(6) **IAB.** To express approval of the outstanding services of the ICSU Abstracting Board to scientific abstracting, and to ratify its extension to biology.

(7) **Freedom of Scientific Research.** To forward a request to National Members to ask their Governments, when ratifying the Law of the Sea, to signify that they will permit scientific research vessels to conduct investigations of the bottom and subsoil of the continental shelf, provided that their programmes are specifically approved by ICSU.

(8) **Policy of Political Non-discrimination.** To emphasise the purely scientific character of ICSU, and of the right of scientists of any country or territory to adhere to, or associate with, international scientific activity without regard to race, religion, or political philosophy.

(9) **Bureau 1958–61.** To elect the following: President, Sir Rudolph Peters (Great Britain); Retiring President, Dr Lloyd V. Berkner (U.S.A.); Vice-President, *Rev. Père Lejay (France); Vice-President, Prof. W. A. Engelhardt (U.S.S.R.); Treasurer, Col. E. Herbays (Belgium); Secretary-General, Prof. Nicholai Herlofson (Sweden); Members, Prof. A. Stoll (Switzerland), Prof. Seiji Kaya (Japan).

(10) **ICSU Capital Fund.** To endorse the decision of the Executive Board to institute an ICSU Capital Fund, with instructions to the Treasurer to invite each member of the Council to take vigorous action to secure appropriate donations to it.

(11) **Publications.** To note the decisions of the Executive Board (*a*) to authorise a new quarterly international journal to be known as *The ICSU Review* (first issue January 1959) and (*b*) to establish an ICSU Publications Office.

This is only a very abbreviated and formal statement of the decision of the General Assembly. Another and a very important aspect of the meeting in Washington was the opportunity it offered of making and renewing personal acquaintance between the scientists of about thirty countries and thirteen different scientific disciplines. The conditions were ideal: the distinguished conduct of the meeting by the President of ICSU, Dr Lloyd Berkner; the welcome by the National Academy of Sciences; the extraordinary kindness, consideration, and hospitality of its officers and staff to their more than 100 guests; and all the opportunities for co-operation under easy and congenial conditions, not only among delegates themselves but with their good friends of the scientific community in Washington. To this should be added a tribute to the administrative staff of ICSU, for their efficiency and good humour. And to one delegate at least, perhaps as a consequence, the striking thing was how everyone was obviously trying, and often working hard in sub-committees and elsewhere, to reach sensible and friendly conclusions, often in fact unanimous. A model for the United Nations!

* Died October 11, 1958.

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

With the last day of last year the eighteen-month IGY was over. Over but not dead. International co-operative geophysics on an expanded scale may be expected to continue indefinitely—as a direct result of the stimulus given to these studies by the co-operation of more than sixty countries, the huge volume of additional data gained and new observatories set up during the year. It may well be years before the full significance of what has been gathered in these eighteen months is fully analysed and understood. But every effort (including the use of electronic computers) is to be made to process the material swiftly and so bring it into the stream of scientific thought. Publication of the results of the Second Polar Year, a quarter of a century ago, is still not complete; such a situation is not to be allowed to develop this time.

Though some achievements of the "Year" will not be known for some time, others have already been absorbed into the public consciousness. The launching into space of the first man-made objects, the final breaching of the last continent, Antarctica—these spectacular events have already marked out 1957–8 from the years before and after.

There can be no question that the IGY and the thoroughfare of intercourse between East and West that it has built up though in itself non-political has had a political value. It has shown that in a world of political hostility and suspicion it is possible and profitable for men of opposed ideologies to work together on specific, limited projects. The committee of experts which met last summer in Geneva on the detection of nuclear explosions confirmed this.

The IGY has been repeatedly cited as a pattern for other co-operative enterprises. From it has sprung President Eisenhower's scheme, now at the draft treaty stage, for sterilising the Antarctic from political rivalries and opening it up for international research. Now something similar is being mooted for co-operation in space research and a resolution is before the United Nations General Assembly seeking to realise this idea. Already special committees with high-level international participation have been formed by the International Council of Scientific Unions, to supervise and co-ordinate effort in both fields of activity.

"The time will come when the International Geophysical Year will be viewed as an important but primitive contribution to the exploration of the cosmos," was the prophecy of Prof. Sydney Chapman, F.R.S., recently. There seems every likelihood of his words proving true.

These are some of the reasons why DISCOVERY *has followed the International Geophysical Year month by month since May 1956 and why we propose covering these matters in the future. The new title, "Geophysics and Space Research", suggests the wider scope one may expect international geophysical studies to follow.*

Magnetic Survey Methods

The first magnetic survey at sea was carried out by Edmund Halley from the *Paramour*, between 1698 and 1700 at the behest of the Royal Society. But the resulting chart gave only one magnetic dimension: declination; instruments for measuring inclination and intensity could not then be operated at sea. Up until the early 1900's Britain had by far the most active record in measuring magnetic changes at sea. The voyages of *Erebus*, *Terror*, and *Pagoda* in southern waters during 1838–43 were the first surveys to measure three magnetic elements. The Fox dip-circle for measurements at sea of the two additional elements had just been devised.

With the turn of the century magnetic surveys began to be hampered by the double revolution at sea—steel ships and engines. Surveys became dependent on specially built non-magnetic ships. The careers of these has been singularly unfortunate. The Carnegie Institution of Washington's ship *Carnegie* blew up with the loss of her captain and chief scientist, James P. Ault, while loading petrol in Western Samoa in 1929. She was nearly at the end of a round-the-world survey, the seventh scientific cruise she had made. Fortunately, her records were sent back to Washington at each port of call so that little of what had been accomplished was lost. Then in 1936 the Admiralty placed a contract for a non-magnetic ship, the *Research*. She was not quite finished when war began and was laid up throughout hostilities at Dartmouth; in the immediate post-war period she fell victim to the usual post-war naval economies and was finally sold in 1946 and is now thought to have been broken up.

Now the Russians have the *Zarya* (see IGY Notes, DISCOVERY 1957, vol. 18, p. 439, and DISCOVERY 1958, vol. 19, p. 297), which has been engaged on magnetic measurements for a year now and is recently returned from the Pacific. Probably the most economical method of carrying out a world-wide survey would be to use aircraft. The Canadians and Americans have developed equipment for measuring all three components from the air with satisfactory results. Mr N. Hill, of the Cambridge University department of Geodesy and Geophysics, has developed a magnetometer that can be towed behind a ship and punches the results on teleprinter tape for feeding into a computer. It was in use for three months this summer with *Discovery II*, but it measures total field only.

FIG. 1. A view of *Erebus* and *Terror* off the Ross Ice-barrier taken from the engraving in Sir James Ross's book, "Voyage to the Southern Seas 1838–43".
(By courtesy of the National Maritime Museum)

THE EIGHTH GENERAL ASSEMBLY OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

Prof. A. V. HILL, F.R.S.
Secretary-General of ICSU 1952–5

The General Assembly was held at Washington, D.C., in the rooms of the National Academy of Sciences, last October. It was preceded by meetings of the Bureau and of the Executive Board, and followed by a final meeting of the Bureau. Present were representatives of thirteen International Unions (the "Scientific Members") and of twenty-nine countries (the "National Members"); together (by invitation) with representatives of Special Committees and other organs of ICSU, and observers from UNESCO, and other international organisations.

The general impression formed was that ICSU has now emerged from its earlier experimental stage and found its feet as a competent and efficient organisation, capable of undertaking important international scientific tasks with wide general agreement and rather little faction. Its administrative secretariat is established at the Palais Noordeinde, The Hague, under excellent conditions provided by the Royal Netherlands Academy and the Netherlands Government. The great success of the International Geophysical Year has encouraged the initiation of two rather similar enterprises, for Oceanic Research and for Antarctic Research. The ICSU Abstracting Board has done such an excellent job in physics, and more recently in chemistry, that the expansion of its work to include biology has been authorised (this will be a very big enterprise). The Federation of Astronomical and Geophysical Services (FAGS) (designed to receive, to analyse, and to synthesise astronomical and geophysical observations, and to make the results generally available) is now fully established. All this is complementary to the traditional objects of ICSU, particularly that of aiding the activities of the International Scientific Unions.

The following are some of the decisions taken by the General Assembly:

(1) **IGY.** To set up a Special Committee for Inter-Union Co-operation in Geophysics (SCG), whose primary task will be to deal with all aspects of the closing of the IGY enterprise. It will start to function on July 1, 1959.

(2) **SCOR.** To establish a Special Committee on Oceanic Research. This is charged with furthering and co-ordinating scientific activity in all branches of oceanic research, biological as well as physical.

(3) **SCAR.** To establish a Special Committee on Antarctic Research. This is charged with furthering and co-ordinating scientific activity in Antarctica.

(4) **IWDS.** To establish an International Service for World Days.

(5) **COSPAR.** To set up an ICSU Committee on Space Research, to function until the end of 1959. Its primary objective will be "the maximum development of space research programmes by the international community of scientists working through ICSU and its adhering Members".

(6) **IAB.** To express approval of the outstanding services of the ICSU Abstracting Board to scientific abstracting, and to ratify its extension to biology.

(7) **Freedom of Scientific Research.** To forward a request to National Members to ask their Governments, when ratifying the Law of the Sea, to signify that they will permit scientific research vessels to conduct investigations of the bottom and subsoil of the continental shelf, provided that their programmes are specifically approved by ICSU.

(8) **Policy of Political Non-discrimination.** To emphasise the purely scientific character of ICSU, and of the right of scientists of any country or territory to adhere to, or associate with, international scientific activity without regard to race, religion, or political philosophy.

(9) **Bureau 1958–61.** To elect the following: President, Sir Rudolph Peters (Great Britain); Retiring President, Dr Lloyd V. Berkner (U.S.A.); Vice-President, *Rev. Père Lejay (France); Vice-President, Prof. W. A. Engelhardt (U.S.S.R.); Treasurer, Col. E. Herbays (Belgium); Secretary-General, Prof. Nicholai Herlofson (Sweden); Members, Prof. A. Stoll (Switzerland), Prof. Seiji Kaya (Japan).

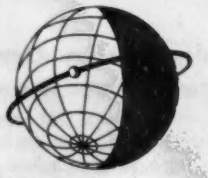
(10) **ICSU Capital Fund.** To endorse the decision of the Executive Board to institute an ICSU Capital Fund, with instructions to the Treasurer to invite each member of the Council to take vigorous action to secure appropriate donations to it.

(11) **Publications.** To note the decisions of the Executive Board (*a*) to authorise a new quarterly international journal to be known as *The ICSU Review* (first issue January 1959) and (*b*) to establish an ICSU Publications Office.

This is only a very abbreviated and formal statement of the decision of the General Assembly. Another and a very important aspect of the meeting in Washington was the opportunity it offered of making and renewing personal acquaintance between the scientists of about thirty countries and thirteen different scientific disciplines. The conditions were ideal: the distinguished conduct of the meeting by the President of ICSU, Dr Lloyd Berkner; the welcome by the National Academy of Sciences; the extraordinary kindness, consideration, and hospitality of its officers and staff to their more than 100 guests; and all the opportunities for co-operation under easy and congenial conditions, not only among delegates themselves but with their good friends of the scientific community in Washington. To this should be added a tribute to the administrative staff of ICSU, for their efficiency and good humour. And to one delegate at least, perhaps as a consequence, the striking thing was how everyone was obviously trying, and often working hard in sub-committees and elsewhere, to reach sensible and friendly conclusions, often in fact unanimous. A model for the United Nations!

* Died October 11, 1958.

GEOPHYSICS AND SPACE RESEARCH



By ANGELA CROOME

With the last day of last year the eighteen-month IGY was over. Over but not dead. International co-operative geophysics on an expanded scale may be expected to continue indefinitely—as a direct result of the stimulus given to these studies by the co-operation of more than sixty countries, the huge volume of additional data gained and new observatories set up during the year. It may well be years before the full significance of what has been gathered in these eighteen months is fully analysed and understood. But every effort (including the use of electronic computers) is to be made to process the material swiftly and so bring it into the stream of scientific thought. Publication of the results of the Second Polar Year, a quarter of a century ago, is still not complete; such a situation is not to be allowed to develop this time.

Though some achievements of the "Year" will not be known for some time, others have already been absorbed into the public consciousness. The launching into space of the first man-made objects, the final breaching of the last continent, Antarctica—these spectacular events have already marked out 1957–8 from the years before and after.

There can be no question that the IGY and the thoroughfare of intercourse between East and West that it has built up though in itself non-political has had a political value. It has shown that in a world of political hostility and suspicion it is possible and profitable for men of opposed ideologies to work together on specific, limited projects. The committee of experts which met last summer in Geneva on the detection of nuclear explosions confirmed this.

The IGY has been repeatedly cited as a pattern for other co-operative enterprises. From it has sprung President Eisenhower's scheme, now at the draft treaty stage, for sterilising the Antarctic from political rivalries and opening it up for international research. Now something similar is being mooted for co-operation in space research and a resolution is before the United Nations General Assembly seeking to realise this idea. Already special committees with high-level international participation have been formed by the International Council of Scientific Unions, to supervise and co-ordinate effort in both fields of activity.

"The time will come when the International Geophysical Year will be viewed as an important but primitive contribution to the exploration of the cosmos," was the prophecy of Prof. Sydney Chapman, F.R.S., recently. There seems every likelihood of his words proving true.

These are some of the reasons why DISCOVERY *has followed the International Geophysical Year month by month since May 1956 and why we propose covering these matters in the future. The new title, "Geophysics and Space Research", suggests the wider scope one may expect international geophysical studies to follow.*

Magnetic Survey Methods

The first magnetic survey at sea was carried out by Edmund Halley from the *Paramour*, between 1698 and 1700 at the behest of the Royal Society. But the resulting chart gave only one magnetic dimension: declination; instruments for measuring inclination and intensity could not then be operated at sea. Up until the early 1900's Britain had by far the most active record in measuring magnetic changes at sea. The voyages of *Erebus*, *Terror*, and *Pagoda* in southern waters during 1838–43 were the first surveys to measure three magnetic elements. The Fox dip-circle for measurements at sea of the two additional elements had just been devised.

With the turn of the century magnetic surveys began to be hampered by the double revolution at sea—steel ships and engines. Surveys became dependent on specially built non-magnetic ships. The careers of these has been singularly unfortunate. The Carnegie Institution of Washington's ship *Carnegie* blew up with the loss of her captain and chief scientist, James P. Ault, while loading petrol in Western Samoa in 1929. She was nearly at the end of a round-the-world survey, the seventh scientific cruise she had made. Fortunately, her records were sent back to Washington at each port of call so that little of what had been accomplished was lost. Then in 1936 the Admiralty placed a contract for a non-magnetic ship, the *Research*. She was not quite finished when war began and was laid up throughout hostilities at Dartmouth; in the immediate post-war period she fell victim to the usual post-war naval economies and was finally sold in 1946 and is now thought to have been broken up.

Now the Russians have the *Zarya* (see IGY Notes, DISCOVERY 1957, vol. 18, p. 439, and DISCOVERY 1958, vol. 19, p. 297), which has been engaged on magnetic measurements for a year now and is recently returned from the Pacific. Probably the most economical method of carrying out a world-wide survey would be to use aircraft. The Canadians and Americans have developed equipment for measuring all three components from the air with satisfactory results. Mr N. Hill, of the Cambridge University department of Geodesy and Geophysics, has developed a magnetometer that can be towed behind a ship and punches the results on teleprinter tape for feeding into a computer. It was in use for three months this summer with *Discovery II*, but it measures total field only.

FIG. 1. A view of *Erebus* and *Terror* off the Ross Ice-barrier taken from the engraving in Sir James Ross's book, "Voyage to the Southern Seas 1838–43".
(By courtesy of the National Maritime Museum)

The Future of Space Research

How to prepare for space-flight discoveries? This was perhaps the most searching question asked at the Royal Society's space research discussion held on November 12 and 13 under the chairmanship of Prof. H. S. W. Massey. It receive a wide range of answers.

Two points were repeatedly emphasised by the speakers (who included several distinguished scientists from abroad). The first of these general comments was that it was necessary to *plan* for the discoveries that could not be foreseen and that these were likely to prove the most interesting. The Van Allen radiation (discovered by the *Explorer* satellites), which is not cosmic radiation but which was first detected by apparatus designed to monitor cosmic rays, is a fair example of such a discovery.

The second point which should be constantly remembered by scientists concerned with experiments from space vehicles is that apparatus and laboratory experiments to back up space research must be pushed ahead fast enough to keep up with advances in rocket techniques. There was already a tendency for advances in rocketry to outstrip the experiments to be carried in the rockets. Earlier in the week Prof. Massey, in a public lecture, had pointed out how much room was wasted in *Sputnik III*. If miniaturised equipment such as the Americans have developed had been carried there could have been twenty or thirty experiments fitted into the 1½-ton nose-cone instead of the mere nine or ten actually carried. But to make the best use of the space available in rocket-probes requires subsidiary research on quite a large scale. "At present the scientists lag behind the engineers at the space game," said one speaker unequivocally.

The Earth's Atmospheric Environment: Prof. D. R. Bates of Belfast drew attention to the change that has taken place in views of the temperature and density of the upper atmosphere between the 1953 Oxford conference on this subject and today. Then it was supposed that at 250 km. the temperature was about 1000° K, and that it rose to this by about 5° K/km. from 100 km., where it was 220° K. Additional material from rocket and satellite probes had now shown that at 250 km. the temperature was palpably higher than the postulated 1000° K, probably nearer 1500° K, and that the rise up to this height from 100 km. was of a higher order than 5° K/km., as previously thought. The density of electrons at 750 km. as measured by the Russians from the *Sputniks* gave a temperature at that height of 2000° K. The amount of energy required to cause such temperatures in the F layer of the ionosphere correspond to 10^{12} ergs/cm.^{3}/sec., and as Prof. Bates pointed out "an enormous amount of energy". It posed the question, where does the energy required to produce such a steep temperature gradient through the ionospheric regions come from? It could perhaps be accounted for by Prof. Sydney Chapman's theory of the Earth being a cold spot lying in the hot outer atmosphere of the Sun (see DISCOVERY, vol. 19, p. 208). Chapman's theory in turn implies that the Sun's magnetic field extends out less far from the solar surface than had previously been supposed.

Dr Homer Newell, the recently appointed Assistant Director of the United States' new civilian body, the National Aeronautics and Space Agency, pointed out that measurements of upper atmosphere temperature from U.S. rockets showed a marked latitude difference. Temperatures recorded by rockets flying from Fort Churchill, Canada, latitude 59° N, agreed well with temperatures recorded by the *Sputniks*. Those recorded by rockets fired from White Sands, New Mexico, latitude 31° N, agreed with the U.S. satellite's findings. A daily variation was also apparent.

Cosmic rays: Prof. C. F. Powell of Bristol, known for his work on emulsions flown from giant balloons, described how much could be learnt about the primary nuclei of cosmic radiation if large emulsion stacks could be flown in satellites. Of course this would require the vehicle to return safely to Earth. He pointed out, however, that such a stack flown at 300 miles up for 100 days would contain fifty times as much information as a balloon flight costing £150,000 carrying a 100-litre emulsion stack could be expected to yield. Prof. Fred Hoyle of Cambridge wondered if there might be a way to detect anti-matter by cosmic radiation studies from satellites.

Probing the Moon, Sun, and Planets: Prof. Thomas Gold of Harvard gave an account which he described as strictly "non-futuristic" of the experiments that might be made from close-circling and other rocket-probes of the bodies nearest to the Earth in the solar system.

The Moon's surface gives the impression of having aged less than that of the Earth. This is curious since it is assumed that both bodies came into being at the same time. Scientists would like to know why the Moon characteristically has craters and *maria*; how deep the surface dust is and whether the Moon was once molten. All this would throw light on the nature of the Earth as well as the Moon and might even be of interest commercially since it might yield information on the mineral structure of the Earth. A rocket circling the Moon could help to answer most of these questions if it contained a television apparatus giving fine detail pictures and was quite close. It is now thought that the Moon may have an occasional atmosphere when gas flung out from the Sun licks round it—this could be sampled from such a probe. A "hard" landing would not give much more information than circumnavigation. If a "soft" landing could be achieved the difficulty would be in deciding what instruments to include of the innumerable experiments possible. A television camera could study the surface from close up, detect any surface motion there might be from erosion or other causes, and if it could be arranged to fire a small amount of grape-shot into the ground it would show how the surface was affected.

Mars is perhaps the most tantalising of the near objects that could be probed from the Earth in the coming years for there might well be life of some kind on Mars. The proposals for instrumentation were substantially the same as for the Moon with the addition of one or two to detect any biological activity. We must be prepared for the existence of life radically different from that found on Earth, which is hydrocarbon based. "Suppose there are rocks that walk?"

A vehicle that could plunge into the Sun was by no means an impossibility, said Prof. Gold. The temperature was much kinder than might be supposed and a probe could well be brought within one solar radius of the Sun's surface. This would enable the extent to which the Sun's magnetic field extended beyond the surface to be measured and it should also be possible to disentangle the reasons for the extreme heat of the solar corona since the probe would pass through this. (A detailed design study of a solar probe capable of reaching to within 4 million miles of the solar surface was presented by a speaker from the General Electric Company of America at the Ninth Congress of the Astronautical Federation in Amsterdam in August.)

Telescopes above the Atmosphere: An optical telescope of 20 in. aperture carried in a satellite is a development that may be envisaged "not enormously far in the future" said Prof. Fred Hoyle, F.R.S., of Cambridge. Such a telescope operating above the atmosphere suggested the most attractive possibilities. Astronomy from the ground had nearly reached the limits of its capacity for probing the universe. Astronomy from above the atmosphere would open up at least three additional ranges of wavelength which are at present cut off from ground equipment.

Infra-red astronomy would enable scientists to study the birth of stars. With present methods the dust particles scat-

tered through interstellar space blocked the view of stars at this highly interesting stage in their development. They could only be seen when the event was complete. A telescope above the atmosphere could make use of electromagnetic waves much longer than that of the interstellar dust and observe stars from their earliest moments.

Gamma-ray telescopes would reveal much that could not yet be learnt of the Crab nebula, the exploded star which raises so many fascinating problems for astronomers. X-ray telescopes in satellites would open up the whole field of the high-temperature gases that are known to exist widely through the universe. "Our galaxy and others are enveloped in large gas bubbles" and these could be studied by x-rays. Surprising as it might seem it was likely to prove easier to put a telescope effectively into orbit than to send a man up in a satellite.

Further possibilities are provided by putting radio-telescopes into satellites. There was really no reason why a radio-interferometer with aerials several kilometres long should not be put into orbit.

Van Allen Radiation. Prof. Chapman delivered a paper by Dr J. Van Allen and his colleagues at the State University of Iowa on this radiation, discovered by the *Explorer* satellites. Latest conclusions from the analysis of the *Explorer* data (about a quarter had been reduced at this stage) point to the radiation being due in some way to the Sun (and not primarily to cosmic rays), and being closely associated with auroral effects. It seemed that the peak of this radiation's intensity lies at about 2 Earth radii and that it extends out as far as 8 Earth radii.

Dr Newell revealed during the course of the meeting that the United States of America has plans to implement almost all the suggestions for space research that had been under discussion, and an experiment that might be expected very soon from an Earth satellite was one to monitor cloud cover above the Earth.

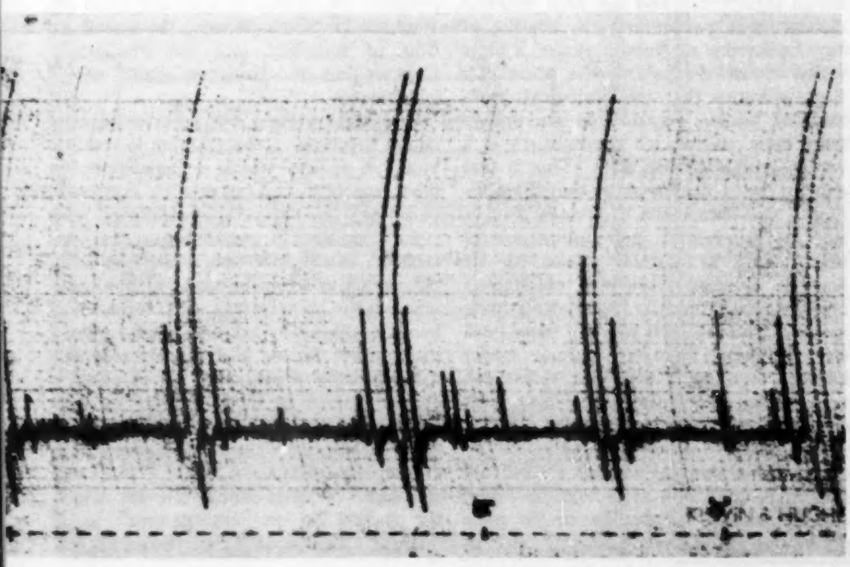
Seeing Satellites Through a Slit

Physicists at University College, London, led by Dr A. P. Willmore, have devised a means of getting visual observations of artificial satellites, of an accuracy comparable with that from the specially developed Schmidt-Baker-Nunn satellite cameras, at a fraction of the cost. The system uses an M-shaped slit mounted in the focal plane of a lens with a photomultiplier behind. An example of the type of record produced is shown here. This was obtained on a single transit of *Sputnik III* rocket on the night of July 23. In order to obtain the five observations the apparatus was swung to follow the object's flight across the sky, and some additional "noise" appears where a star was momentarily in the field of view.

The angle at which the satellite crossed the four slits of the M can be deduced from the time interval between the individual "blips" in the four-blip pattern. Brightness is indicated by height above the line. The time-scale is shown by the one-second pulses from a chronometer marked on the paper (see Fig. 2). There is a substantial gain in accuracy with a faster recorder speed; that used on this test run was slow. The apparatus which is set up in the grounds of the BBC listening post at Tatsfield, Kent, is now being run at a higher speed. Nevertheless this record clearly shows the marked variation of the rocket's brilliance thought to be due to tumbling. The transit can be measured to an accuracy equivalent to one minute of arc even at this low running-speed.

The method has proved sufficiently promising for it to be thought worth while to design an optical system specially for this work instead of using service surplus equipment as at present. This is to be done. It also appears that objects as bright as *Sputnik III* rocket could be detected in daytime by this method with a field of view of about 0·5°.

FIG. 2.

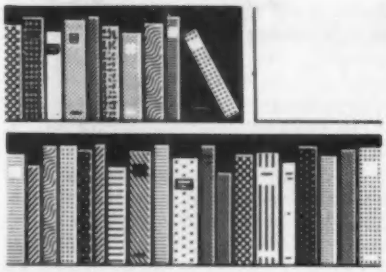


Man-made Aurora?

For the first time since May 1921 an aurora was observed at Apia, Samoa, which lies only 14° from the Equator, on August 1 last year. Apia lies to the south of the Equator but part of the display on August 1 was visibly to the north and as high as 32° above the horizon. Another curious thing—the previous aurora witnessed from Apia coincided with a very severe world-wide magnetic storm; nothing of the kind occurred on this occasion. A magnetic disturbance of considerable magnitude was recorded at Apia but this appears to have been quite localised and no world-wide disturbance was observed for that period.

These unusual observations made by Mr J. G. Keys at Apia Observatory on August 1 has led Dr A. L. Cullington, of the Geophysics Division of the New Zealand Department of Scientific and Industrial Research, to conclude that this aurora was a man-made effect, the result of the explosion of a large, high-altitude nuclear bomb by the Americans at Johnston Island in the Central Pacific as part of their recent test series. Johnston Island lies about 2000 miles to the north of Apia. A magnetic storm localised in the Central Pacific was observed to begin in a rather curious manner at about the same time as the nuclear explosion is thought to have taken place; the auroral display over Apia began about one minute after. It began with bright rays in the western sky, at first violet and reds, changing gradually to greens. A crimson arc to the north with its centre 32° above the horizon was also visible. To the south three or four red bands extended even higher up the sky.

Two conclusions are drawn from this occurrence. It appears that the auroral effects must have been caused by particles from the explosion. Also that the explosion must have taken place at a very great height, auroral heights in fact, which suggest a rocket launch. There is no other explanation for the ability of the particles to penetrate distances of more than 3000 miles without losing their energy in collisions with the atmosphere.



THE BOOKSHELF

Statistical Theory

By Lancelot Hogben, F.R.S. (*George Allen and Unwin Ltd, 1957, 510 pp., 45s.*)

In his latest work, Prof. Lancelot Hogben has let himself go on the subject of the philosophical foundations of statistics. It is, of course, this aspect of statistics which has given rise to most controversy. The sub-title of the book, "An examination of the contemporary crisis in statistical theory from a behaviourist standpoint", is misleading. The keen controversy of recent years continues unabated; the main contestants have not moved perceptibly nearer to each other. But the author himself quotes Prof. Barnard, who fairly describes the current debate as "really, from a practical point of view, a discussion of the fine points of detail. All statisticians agree about what should be done in practical problems." There is, therefore, no need to be surprised that many working statisticians have not felt it necessary to take up a stand on behalf of one or other of the three rival views advanced by Fisher, Jeffreys, and Neyman and Pearson.

The author, writing with characteristic vigour and candour, does not attempt to resolve any of the questions in dispute, aiming rather to present them in their proper historical perspective. The aim of the book, he says, is "to trace disputable claims of statistical theory to their sources". The work is enlivened by expressions of the author's own views on each of the stages in the dispute, which he traces back to the days when discussions centred on the laws of gambling.

Perhaps the main weakness of the book is that it is not clear for what class of reader it is primarily intended. If it is the student, too much is taken for granted; if the academic statistician, much of it will be only too familiar to him. Practising statisticians, for whom it is perhaps mainly intended, may find some of the discussion too discursive for their tastes and may have difficulty with the unfamiliar notation.

As a first bold attempt at an historical account of the subject, the book is nevertheless welcome and valuable; and it should provide a salutary corrective to the very inadequate treatment which is to be found in, or is missing from, most of the textbooks.

J. L. NICHOLSON

No. 26—Radio Astronomy: a Special Subject List

Compiled by F. R. Taylor of the Library Association (*15 pp., 3s. 6d.*)

The Library Association has issued, as its special subject list No. 26, a highly selective bibliography of radio astronomy. This contains references to thirty-three books or individual chapters in compendiums, and to 200 papers. Most of these papers have appeared since 1950, in journals which are readily accessible in this country. These papers are restricted to the techniques and results of the study of radio emissions from extra-galactic and galactic sources, and from the Sun and planets.

The study of the Moon and of meteor trails by the radio-echo techniques has yielded many results of interest to astronomers and to geophysicists, but papers on these branches of radio astronomy are scarcely mentioned. Within the restricted field, however, the list should prove a very useful and not over-expensive guide for newcomers to the subject.

H. P. PALMER

Variation and Heredity

By H. Kalmus (*London, Routledge and Kegan Paul Ltd, 1958, xi+227 pp.*)

This book starts with a discussion of the measurement of variables and the types and origins of human variation. The central section is a description of Mendelian inheritance and the final chapters discuss more particularly the bearing of new knowledge on human affairs, a topic which recurs throughout the book. Dr Kalmus states that the biological problems of human populations are unique since man controls his environment in a way no other species does. This is true enough, but I do not agree that the techniques and conclusion developed in considering non-human populations are as inapplicable to human affairs as Dr Kalmus implies. Students of human genetics have usually been men with medical training, and as they have been working with man—an animal better known than any other—it has been natural that their researches have been detailed, clinical and exhaustive, and as far as possible precisely applicable by doctor to patient. As a result a relatively numerous collection of conditions which can be isolated as due to simple gene differences have been worked out in detail, but the broader topics remain largely unexplored. Restricting the discussion to conclusions drawn from human genetics alone restricts it to single-gene situations, but problems of human evolution are multigenic and concerned with population dynamics, a subject only mentioned in this book. The emphatic statements on the ineffectiveness of sterilisation as a eugenic measure are very welcome; but some discussion of the less obvious, and probably unconscious, eugenic measures often taken would have been equally welcome.

J. M. RENDEL

Science and Education at the Crossroads: a view from the Laboratory

By Joseph W. Still (*Washington, D.C., Public Affairs Press, 140 pp., $3.75*)

Dr Still's purpose is a general analysis of the present crisis in American science and education, and while he writes from the standpoint of the expert, he is addressing primarily a lay public. If his tone is sometimes iconoclastic and his analysis prone to simplification, it must be conceded that his utterances are long overdue. This is particularly true of the early chapters which deal with the short-term problem. He highlights the inadequate representation of science in government; we learn, for example, how Mrs Hobby, former Secretary of Health, Education, and Welfare, set a deadline of 75 minutes to the committee trying to decide whether to release Salk vaccine, and how there was not one working scientist present at President Eisenhower's first conference to consider the implications of the *Sputnik*! Whether Dr Still's remedy, the introduction of scientists into the President's Cabinet and into Congress would work, is debatable.

The educational system receives equally rough handling. Centralisation is seen as vital. A society which is dependent on labour-mobility is hampered by vast local variations in educational facilities and standards; equally restricting is the use made of intelligence tests which can only be applied to a limited range of qualities, whereas the aptitude of a child for science needs assessing in relation to the whole personality. Indeed, a significant enlargement of the educational pool requires encouragement of curiosity and science-mindedness on the part of children through a more widespread nursery and kindergarten education, while to meet the shortage of science teachers, every scientist should do an "interne-tour" as a teacher. To improve the financing of

research, the authorisation of endowments purely on a personal record rather than a project basis is (less convincingly) recommended, and there are fertile suggestions to better America's cumbersome system of scientific communications.

These issues apply in Britain as well as America, and readers should welcome the timeliness of this pungent book.

D. GINSBURG

La Gelée Royale des Abeilles

By B. de Belvefer (*Paris, Librairie Maloine, 1958, 470 pp., 4 gns.*)

Among the many remarkable and wondrous things about bees is the fact that they feed their grubs on a gland secretion which is comparable to the milk produced by mammals for the nourishment of their young. This "brood-food" is generated by the worker bees in modified salivary glands. Larvae destined to be reared as workers are given this food only for the first few days of their life, after which they are also fed on pollen and honey. Queen bees are reared from larvae fed solely on the special food, but quantity alone is not the deciding factor; the "brood-food" supplied to the growing queen bee appears to contain traces of additional specific substances the precise nature of which is not yet known.

Since the life of the worker bee is measured in weeks or at the most months, whereas the queen bee attains an age of four to five years, it has been thought that "brood-food" taken from the nursery-cells of queen bees (the *gelée royale*) might have a beneficial and life-prolonging effect on human beings. Who indeed would not be willing to take so attractive and harmless a medicine! *Gelée royale* has already become an article of commerce and is sold on a considerable scale.

In this book, M. Belvefer states that he himself gave the original impulse to this development, by encouraging beekeepers to supply the raw product in substantial quantities. The book goes on to describe the great efforts made to solve the problem of conservation without loss of vitamins and other essential constituents. Further sections of the book deal with the composition of this remarkable substance and with the growth of knowledge on the subject from the earliest times.

The book also contains an account of tests carried out with conserved *gelée royale* on animals and human beings. Among the claims made for it are stimulation of the sexual function in ageing subjects and beneficial effects in arteriosclerosis and other manifestations of senility. Some of the described tests cover only a very short period of observation, and there is no mention of counterchecking or control tests. In fact, the reader is left with the impression that the book is more a piece of persuasive publicity than a work of scientific exposition. There is as yet no conclusive proof that *gelée royale* contains any specifically remedial principle.

K. VON FRITSCH

The Gentle Art of Mathematics

By D. Pedoe (*London, The English Universities Press, 1958, 143 pp., 15s.*)

This book is written for laymen who wish to know what mathematics, and especially modern mathematics, is about. Popular expositions can counterbalance the division of knowledge into increasingly specialised compartments and remove some of the dislike, and even fear, of mathematics which so many people acquire at school. Unfortunately many recent books of this type have shown marked similarities, conforming to a pattern which almost implies that a standardised syllabus has been drawn up for the inquiring amateur; but this new one is refreshingly different.

The chapters on automatic thinking, symmetry in geometrical patterns, and on modern views of the foundations of mathematics are not duplicated in other English books for non-specialist readers; and even when writing on more frequently treated topics such as choice and chance, topology, geometric series, and the theory of Nim, Prof. Pedoe's presentation has an elegant simplicity which fully justifies the title which he has chosen. He is, after all, a distinguished geometer; and elegant simplicity is the outstanding quality of good geometry.

Although the technical difficulties of the mathematical manipulations are small, considerable thought and maturity are required from the reader. The discussion of probability theory indicates certain logical difficulties which have long been unresolved, the two letters from Newton to Pepys (quoted in full) are by no means easy to follow, and considerable general knowledge is required to seize upon and savour the quick succession of witty asides which give Prof. Pedoe's style its own characteristic flavour. Here is not so much the mathematics of Friday afternoon at school as the mathematics of an after-dinner speech. Enjoyment is the keynote, and the author hopes to transmit to others the joy which he finds in the practice of his art. We meet many of the evergreens of recreational mathematics, but the aim is always to deal with general principles, and seriousness always underlies the easy-going humour.

Suggestions for further reading would have been valuable, and it is a pity that none are included. Apart from this, the book is well produced with many attractive illustrations, and the only complaint is that it is far too short. This the author can remedy by writing a second instalment; and we hope that he will.

T. J. FLETCHER

Gem-stones

By G. F. Herbert Smith, revised by F. Coles Phillips (*London, Methuen, 1958, 560 pp., 13th Edition, 50s.*)

That this book has achieved the importance of a 13th edition suffices to indicate the value of the text. This new edition has certainly been most carefully brought up to date, including for example, a comment on the recent synthesis of diamond achieved in the U.S.A. The book has four main divisions: (I) Physical characteristics of Gem-stones; (II) Technology and History; (III) Detailed descriptions of Gem-stones; (IV) Identification Tables. Perhaps the only criticism that can be offered regarding balance of material is that diamonds seem to occupy a somewhat excessive amount of space.

Throughout, the style is delightful and informative and a vast amount of ground is covered. The book contains, indeed is based on, a large number of admirably executed clear diagrams; there are a number of very attractive coloured plates and several excellent photographic reproductions, especially those associated with technological processes. The new revised section dealing with the morphology of the crystals is cleverly simplified for the non-specialist with no loss in accuracy. Not a single misprint was discovered from cover to cover, a rare event in a book as large as this and as densely packed.

G. F. Herbert Smith recognised that gem-stones included semi-precious materials, such as are often used for carving, as well as precious stones. He therefore added to the value of the treatise by including sections on ivory, coral, jet, tortoiseshell, and pearls. One tends to think of gem-stones as minerals, yet undoubtedly the gemmologist and the jeweller meet these other materials of organic origin either as precious or as semi-precious objects, and there is certainly much justification for including a comparatively brief survey of these substances. The chapter devoted to pearls is particularly thorough and makes delightful reading.

This volume can certainly be recommended as a basic text for the gemmologist and the lapidary. The authority of this book is obvious and it can be dipped into with much profit by the mineralogist, the crystallographer, the physicist, and even the historian. There is a most extensive and learned bibliography,

which includes special coverage of the vast historical output of publication on the subject from the earliest records down to the very present. Indeed, in this new edition it is clear that the reviser has paid particular attention to bringing the bibliography right up to date.

Altogether this is one of those rare books one takes pleasure in recommending without any reserve whatsoever.

S. TOLANSKY

New Ways in Management Training

By Cyril Soper, Geoffrey Hutton (*London, 1958, Tavistock Publications Ltd, 127 pp., 15s.*)

This is a book which should be of considerable interest to the staffs of all technical colleges, to the various bodies exercising authority over the activities of such colleges, and to senior members of industrial and commercial management.

To the staff of technical colleges because, although the work is concerned with the experiences of one particular college, it clearly identifies and examines those problems which, in large measure, are common to all such establishments. There can be few instances where there is unawareness on the part of the reader of the matters dealt with in Chapters 2, 3, and 4, but perhaps fewer still where an opportunity has been found to investigate, ascertain causes, and formulate remedies relating to the problems there set out. Not every technical college will have access to the services of an organisation such as the Tavistock Institute of Human Relations. A knowledge of the results of the research carried out at Acton will be of immense help to those seeking to break through the barrier of mutual inadequacies of understanding and appreciation which prevents that degree of co-operation between industry, commerce, and the technical colleges. The vital importance of such co-operation is appropriately developed in "New Ways in Management Training".

Members of controlling and advisory authorities will find in Chapter 10 an implied exhortation to recognise that unless and until there is a fearless, single-minded, and scientific approach to the recognition, assessment, and solution of the problems at present handicapping the technical colleges, those institutions cannot hope to establish reputations as centres capable of imparting a worthwhile knowledge of the principles and practices of scientific management. From the text of the book one gathers the impression that far too little management authority is vested in the staff of technical colleges, far too little time free from lecturing duties permitted, and too few opportunities given to develop practical management ability.

Senior members of industrial management are, with lamentably few exceptions, unwilling to extend the principle of specialisation to the teaching and training of staff. There is still a very great deal of unreasoned mistrust of what is thought to be impractical theory and a disinclination to afford opportunities for the application of theory to practice. This book contains a challenge to such managers. As tax- and rate-payers businesses purchase a potential asset which, usually through prejudice and ignorance, they fail to use. This is behaviour which managers would wholeheartedly condemn in relation to any other kind of financial outlay.

The style and method of presentation adopted in "New Ways in Management Training" is not perhaps as attractive to business men as it could be, and this is unfortunate.

A criticism that must be made is that the number of errors that appear in the text are more to be regretted in a work of this kind than one of less academic origin.

S. H. ALLOWAY

Science Students' Guide to the German Language

A. F. Cunningham (*Oxford University Press, 1958, 186 pp., 12s. 6d.*)

It is questionable whether linguists will acknowledge the validity of such a subject as Science German. Inasmuch as it does exist as a specialised jargon, our scientists are still inclined to think that it can and should be learned without bothering too much about German as such. This leads to emphasising text-material that will cultivate a scientific vocabulary, but this is the least of the problems facing the learner. On the other hand, the mastery of basic grammatical forms and a sound grasp of syntax tend to receive insufficient attention. It was to counter this trend that a recent conference of H.M. Inspectors and others said very firmly that even science students should not be given specialised material.

It is therefore interesting to see a new primer of German emanating from that Faculty of Science which more than any other has succeeded since the war in integrating German into its curriculum. The results achieved at the University of Birmingham have astonished the sceptics; students of science and engineering have even become interested in the language. In view of this it is a little disappointing that we find in this book no new or experimental approach to the subject. We are given a thoroughly reliable digest of essential forms and usages, presented in the traditional manner and sequence. Only in the chapter on the plural of nouns is there any departure from orthodoxy. But here the reviewer cannot agree that the new classification is a happy one: instead of the customary four main groups based on plural forms we have five classes, four of which depend on a knowledge of the noun's gender. This ignores the fact that students commonly find the plurals easier to remember than the genders. Particularly welcome are the two chapters devoted to a clear discussion of word-order and the final chapter on participial phrases.

It is the editor's expressed desire to avoid examples constructed for the purpose of illustrating grammatical points. Laudable though this may appear, it is doubtful whether sentences and passages chosen with this aim from scientific writings can in practice focus the attention sufficiently on the point under discussion. Simpler material here would have made for easier going in the grammatical section. Another and equally serious methodological shortcoming is unavoidable when "genuine" text is used. It is virtually impossible to correlate it sufficiently closely with the grammar that has already been dealt with. We can find in every reading passage a number of major difficulties that are not treated until later on. With a teacher at hand this may not be a serious drawback, for these points can be touched on in passing. A student working without a teacher would however be advised to run through all the grammar before attempting to read even the passages in each chapter.

The 100-page grammatical section is followed by 80 pages of reading passages which give an excellent cross-section of modern scientific prose. As with all such selections the question arises whether the chemists are expected to read about television and the mathematicians about antibodies. The reviewer shares the opinion of H.M. Inspectors that texts of a wider general interest would provide better material for learning to read.

H. T. BETTERIDGE

Brief Notes

The full Proceedings of the Corrosion Convention, held in London last October, is now available ("Industry Fights Corrosion", 107 pp. illustrated, Corrosion Technology, London, N.W.1, 21*s*., post free). Organised by Corrosion Technology, the Convention was attended by over 500 delegates from the U.K., Europe, and America. Thirteen papers dealing with different aspects of the corrosion problem were delivered and discussed over two days, subjects covered including corrosion in the shipping, petroleum, atomic energy, and chemical industries; metals, paints, and plastics were discussed. Other subjects included packaging, water treatment, cathodic protection, fuel additives, hot galvanising, and the protection of buried pipes.

SCIENCE ON THE SCREEN

Scientific Cinematography in the U.S.S.R. Scientific cinematography in the U.S.S.R. is making a material contribution to the scientific and technological progress of the country. The subject is dealt with there under three main heads: (1) popular science films; (2) educational, including instructional films; and (3) scientific research films. These in turn are broken down into a number of subdivisions to correspond with the aim of the film.

According to information published in Moscow recently, a three-year plan has been drawn up for the production of popular science films, and approximately 400 new films may result from this venture. Of first importance will be those dealing with technical progress and the progressive methods of work in industry. It is anticipated that some twenty-six films will be devoted to the achievements of Soviet science in the exploration of outer space. A number of research films dealing with space medicine are to be made into one documentary, in order to show audiences the branch of science which studies the physiological effects of travel in outer space. In this connexion one of the most interesting research films seen at the recent XIIth Congress of the International Scientific Film Association in Moscow was presented by Isakov (U.S.S.R.). This film dealt with the use of cinematography for scientific research in space medicine, and showed the behaviour of dogs during rocket flight under conditions of weightlessness.

The importance which is attached to scientific cinematography in the U.S.S.R. may be judged to some extent by the fact that there is a Chair of Scientific Cinematography at the State University of Moscow. This is held by Prof. K. Tchibissov, who explained to the ISFA delegates that his Department had been in existence ten years, and included responsibilities for (*a*) teaching, (*b*) research, and (*c*) introduction of films into courses at university. About 2000 students attend these courses per annum. Great attention is paid to teaching cinematographic methods, because this is thought to be the best way of introducing teaching and research films to those who, later on, may themselves be teaching at the university.

A wide variety of subjects is included under the heading of research, but the main direction is in the study of scientific and technical methods (special techniques of cinematography), and the utilisation of these methods in teaching. Research is carried out under the supervision of a lecturer, who is assisted by other members of the department. They claim to have tacked the following problems: luminescent cinemicrography, high-speed cinematography (up to 100,000 f.p.s.), high-speed cinemicrography, cinematography in infra-red, cartoons, etc. Methods for filing films have been evolved, whilst a number of films have been produced, including experimental educational material. The university has seventeen classrooms equipped with cine projectors, and 1500 lectures are given each year with the aid of films. The large film library includes 700 titles, covering films made by the university department, as well as re-edited versions of "Popular Science" films. A number of examples were shown to the ISFA delegates when they visited the university, including archaeological excavations, astronomical research, geology, and physiological experiments.

All this must have a profound influence on the development of scientific cinematography in the U.S.S.R., but the effort by no means stops here: the association of film-makers in the U.S.S.R. has a headquarters and cultural centre. The Congress was in fact staged at these headquarters, where there are four projection theatres, including one with seating capacity for some 1500 people. DOM KINO, as it is called, was founded in 1957 at the request of the creative workers of the cinema. Its members are said to be eminent film directors, cameramen, distinguished actors, screen-writers, and so forth. There is a nominal membership fee of 120 roubles per annum. The Government apparently provides an annual subsidy of 20 million roubles, as well as the very fine central headquarters mentioned, and another building known as the Film Museum, which is near Moscow. The latter is referred to locally as "the house of creation"—a place where workers can prepare scripts or screen films in quiet and congenial surroundings. Also included in the scheme are two sanatoria on the Black Sea. DOM KINO is organised on the following lines:

1. Council (Praesidium).
2. Section for:
   - (*a*) Art cinematography (feature films).
   - (*b*) Scientific cinematography.
   - (*c*) Documentary films.
   - (*d*) Theory and criticism.
   - (*e*) Script-writing.
   - (*f*) Animated cartoons.
3. A department for international relations with other film organisations.

It is interesting to conjecture why the Soviet believe it worth while to make such extensive use of scientific cinematography. Undoubtedly it helps scientists to observe phenomena which the eye cannot normally see, but it also provides a visual means of stimulating thought on new lines of research. Moreover, in showing young people popular science

FIG. 1. Photograph shows V. N. Surin, Deputy Minister of Culture, and Chairman of the Organising Committee of the International Scientific Film Association giving a welcoming speech (on his left is the interpreter). Also on the platform are John Maddison, Honorary Secretary of the Association, Luc Haesaerts, retiring President of the Association, and Jean Painlevé, Honorary Life Member of the Council of the Association.

and instructional films, they can see the value of research and the great attractions of a scientific career. It raises the question of whether we in Britain should be looking at scientific cinematography more carefully. In some quarters it may still be regarded as an expensive toy. In the U.S.S.R. it is no less expensive, but is being employed as a really efficient and effective weapon in the advance of science.

Although feature films are really outside the scope of this note, it may not be out of place to mention what is being done in this field. Delegates to the ISFA Congress visited the Moscow Film Studio, which is the largest in the U.S.S.R. They claim to have seven studios, ranging in size from 800 to 17,000 sq. m. and some 3500 employees. Three more are under construction and when completed, in two years' time, it is hoped to produce forty feature films per annum. The Studio will shortly start working on broad gauge film (70 mm.). Producers have a free hand to decide whether to use black and white or colour, but it is anticipated that about 70% of the feature films will be in colour. The Studio covers the full film cycle—scripting, production, camera work, and any research required to achieve the best results.

L. POOLE

Taped Vision for Associated-Rediffusion

The American VR-1000 videotape recorder has been introduced into this country by Associated-Rediffusion Ltd. The videotape recorder is similar in principle to an audio recorder, but a video signal contains of the order of 1000 times as much information as an audio signal. This means that the recording of video on magnetic tape involves either scanning across a broad tape or using a conventional tape at very high speed. The BBC, as recently demonstrated, has opted for the latter technique, whereas Associated-Rediffusion have chosen the former.

In the Ampex system the 2-in. magnetic tape moves at only 15 in. per second past a rotating disc. On the circumference of the disc are four magnetic heads spaced 90° apart with their gaps parallel to the disc axis. The video signal is recorded in almost vertical tracks which scan the tape. A concave guide cups the tape as it moves past the rotating disc while a vacuum is applied from the guide side of the tape. Thus, good head contact at nearly constant pressure is assured. This system permits high head-to-tape velocity without undue consumption of tape, and without the mechanical problems of transporting tape at very high speed.

The transverse video tracks are 10 mil. wide; their edge-to-edge separation is 5·6 mil., and their centre-to-centre spacing is 15·6 mil. Using thin tape, 64 minutes of recording are obtained in a 12-in. diameter reel of 2-in. tape.

The sound track is recorded horizontally at the top of the tape by stationary heads. During recording the sound track is wiped clean by a preceding erase head for maximum signal-to-noise ratio. A control track is impressed along the bottom of the tape, and in play-back the scanning system is coupled to this control signal to ensure perfect synchronisation of the tape and recording heads. Superimposed on the control track 10 mil. above the bottom edge of the tape is a cue track which serves as a guide for operators and programme directors. Also on the control track are edit pulses used as reference points in the editing and splicing.

The image produced by videotape has the authentic look of live television. Unlike film, videotape can be erased and re-used at least 100 times. It can be ready for play-back immediately, whereas film may require eight hours for developing. Recordings on videotape cost less than a quarter as much as equivalent recordings on 16 mm. film, and less than 1/10 as much as those on 35 mm. film. Editing without waste is possible, and the equipment, including all components and adjacent working area, requires less than 100 sq. ft. of floor space.

The equipment is manufactured by the Ampex Corporation and modified to British standards by Rank Cintel Ltd. Installation and supervision of the project has been carried out by Central Rediffusion Services Ltd, technical advisers to Associated-Rediffusion Ltd.

Special TV for Atomic Power Station

The first order for a television nuclear reactor camera has been placed with Pye. It will be used at the Central Electricity Generating Board's Bradwell atomic power station.

The camera will help engineers to inspect the interior of the station's two reactors when they come into operation during 1960.

The first of three Pye TV cameras for exclusive use in the atomic energy industry was put into operation at Calder Hall in 1956. It was 3 in. in diameter and 40 in. long and had its own source of illumination. A special cooling system was also provided.

The second camera, which was designed hurriedly for a special purpose in 1957, led to the development of a camera which incorporates facilities for handling objects within the reactor core.

It is a camera similar to the latter which is to be delivered to the Central Electricity Board some time next year.

Man-made Rubber

A 16-mm. film with the above title, in colour, dealing with the manufacture of synthetic rubber, is now available on free loan from the Dunlop Film Library, Wilton Crescent, S.W.19. It is especially suitable for sixth forms or for general audiences with an interest in popular science subjects. Running time is sixteen minutes.

Television

On November 12 the BBC broadcast "Breakthrough", a programme in the series "Eye on Research"; its object was to focus attention upon the events of the past year associated with space exploration. The programme was on a most ambitious scale and all the forces available to the BBC were brought in. The executive producer, A. E. Singer, had in the production team B. Duncalf, B. Wright, R. Lakeland, and P. Daly. The programme was tied together through narration from R. Baxter and sound technical advice came from Prof. H. S. W. Massey, F.R.S. The programme was divided into four interrelated sections: rockets and their fuels; the launching and tracking of satellites; space medicine, which dealt with the physiological problems that space travellers would encounter; and finally the future. Viewers were told this programme would give an international story covering no less than five scientific establishments in Great Britain, one in Australia, four in the U.S.A., and finally film extracts provided by the Soviet Academy of Sciences.

The broadcast commenced with an excellent introduction from R. Baxter giving a summary of why space was under attack. After a brief visit to the rocket-propulsion establishment at Westcott, live demonstrations of the firing of rocket motors at the Larkhill station of the Royal Aircraft Establishment were shown. This part of the broadcast was too technical, which is so often the case when outside broadcast experts are before the camera. Terms such as Doppler, telemeter, oscilloscope, etc., are meaningless to millions without at least a word or two of explanation. There was some fine split-second timing in camera work during this part of the broadcast. A brief film of a rocket launch from Woomera, Australia, and we were switched back to R. Baxter, who, at this stage, had some difficulty with his technical briefing. There was, however, an admirable animated diagram of the mode of operation of a liquid-propellent rocket engine.

There followed one live item, which was of considerable scientific interest, a rocket motor firing. It gave a magnificent example of standing shock-waves which

were only briefly mentioned and not explained.

At this point the satellite story was taken up and as a promised Russian film did not materialise, we had instead a film from the U.S.A. This was over-technical and filled with unexplained jargon such as "thermistors", "solar cell", etc., all most stimulating to a physics student, but of little guidance to the main television audience. After forty-five minutes Prof. Massey was brought in and he gave a lucid, admirable statement of just what is emerging from the data supplied by the satellites. He divided the findings into information about (*a*) the density of the atmosphere; (*b*) the shape of the Earth; (*c*) the pressure of the upper atmosphere. It was a pity that he was brought in at so late a stage. Perhaps too much time was wasted on the notorious rocket-launching films.

After minor technical hitches the moon-probe experiments were discussed, followed by another film of a rocket launching. We were switched to Jodrell Bank experimental station and the broadcast descended to a dull, dreary exhibition of quite meaningless telemetering records. This might well have been left out.

Finally the broadcast ended with some exciting reports from the Institute of Aviation Medicine at Farnborough. Films were shown on the effects of increased gravitational forces (although there was failure to explain to the layman the meaning of the phrase "to experience 3g"), underwater experiments, and aviators floating around in a plane flying on a course which reduced the Earth's gravity practically to zero. From Russia, all that could be raised was a few moments of film showing a barking dog, and it was of such inconsequence that it might just as well have been left out altogether.

In some brief concluding remarks about the future, Dr F. Hoyle, F.R.S., the distinguished astronomer, asked that no men as yet be sent up in rockets but only instruments, arguing that the space available in a satellite was far too valuable scientifically to be wasted on the limited senses of man and could be much more profitably employed by filling up with suitable detecting instrumentation for heat, spectra, ionisation radiation, etc.

The impact of the whole programme was considerable, but too overwhelming. After this most novel experience in broadcasting one comes to the reluctant and hesitant conclusion that one hour of intensive technology is probably too much for most people. The pace was intense, the content formidable, the range enormous. The producers were undoubtedly right in attempting this formidable production. It might be imagined that they will not be too anxious to try so heavy a project again for some long time to come. It was, after all, not merely a long broadcast, it was a highly complex one. Nevertheless we were very glad to see it, despite its occasional minor defects.

Also during the month of November (on the 13th) we had another edition of J. McCloy's "Science is News", which was introduced by R. Bradford. An interesting quarter of an hour was devoted to sub-threshold perception and the much-discussed possibility of subliminal advertising. The subject was brought to us by Dr T. Margerison, with assistance and experiments first from Dr N. Nixon and then from Prof. Drew. What was attractive was the informal character of the typical laboratory "hook-up" shown for real research. The more the general viewer realises how real research is conducted, the better, and research is rarely carried out on the grandiose scale available to Government atomic energy departments. Scorn was poured on the subliminal propaganda stories which are current, largely because the evidence shows that there is so big a variability range in threshold that any subversive attempts are bound to be recognised by large numbers and thus the purpose is defeated.

The next item was devoted to radar, both man-made and to analogous phenomena in the animal world. We were shown the highly complex radar installations in the jet aircraft Comet IV and then the analogue between this and the "radar" mechanism used by bats in flight was stressed. We were treated to a very fine piece of film illustrating the bat obstacle-detecting mechanism and the tie-up with aircraft radar was made delightfully clear. Altogether an admirable ten minutes.

The next section was devoted to a discussion of current research on the common cold and was essentially an illustrated conversation between the TV science doctor and Dr Andrews, who is in charge of the research work going on in this field. This was a valuable discussion between experts and one learnt much in a short time about the mysteries of common cold infection.

The programme ended with a film illustrating froth separation of coal-dust. It was reasonably good but too short to be of much use and the time might have been better distributed amongst the previous three subjects.

Taken as a whole the programme was a good serious contribution and much of value was packed into the half-hour.

We have here an interesting opportunity to compare two techniques, the heavy, hard-hitting programme lasting a whole hour on November 12, and the more light-hearted approach on November 13. Their proximity made it easy to compare the two. It seems to me that neither technique is satisfactory, the one is too heavy, the other too light. One is led to the conclusion that a single subject delivered for half an hour seems, in fact, to be the correct happy medium and many of the programmes praised before in these columns certainly seem to bear this out. This idea has long been advocated here and these two interesting extremes add strong support to this view.

S. TOLANSKY

LETTERS TO EDITOR

Sir:

We must be most grateful to DISCOVERY for the interest shown in reviewing the science and schools television programmes. In the Schools Department of A-RTV it is always interesting to read the views of informed people, in addition to the many daily reports from teachers and educationalists who are actively using the programmes.

It is interesting to note that nearly all the reviews of the schools science series during the past year have been diametrically opposed to the observations of the educationalists. Where Prof. Tolansky praised, the teachers condemned; where he condemned, they praised. I can only suppose that he is reviewing the programmes as general public transmissions and not as programmes designed for the classroom.

Prof. Tolansky urges: ". . . a whole class ought to be televised; the camera should be placed as though it were one of the back row of a class and thereby heighten the illusion of a real school lesson in progress."

Why should this illusion be made? It would surely be a great waste of television to emulate what can be done in the classroom. If something can be done in the classroom, almost certainly it can be done better than it could be on the television screen. It is generally agreed that there is no substitute for the direct contact of a good teacher in primary and secondary education.

Further, although children on the screen may prove to be a great favourite with adults, they tend to be a disaster if projected in front of their contemporaries.

Prof. Tolansky liked "the personal touch of the live broadcaster, which showed up only too well the relative poverty of a pure film broadcast". There are, it is agreed, some superb live broadcasters, and for a series of schools programmes which can be only frugally illustrated, they may be the answer.

If, however, a subject can be only frugally illustrated, maybe it is not the best choice for schools television.

If the subject-matter is such that it can be fully illustrated, what point is there for the schoolchild to see a narrator, unless he be an expert like Sir John Cockcroft whom it would be worth while the child seeing and hearing as a personality of today.

Schools reporting on past science programmes have indicated a desire to look more at what is being described than at the describer. This is being tried, and judging by current reports, it is successful. The schoolchildren aimed at seem to have no particular desire to see the owner of the disembodied voice.

Prof. Tolansky was inaccurate in his remarks when commenting on the first programme in the series, "Matter in Use". He said: "The main, and surely justifiable, criticism is that from beginning to end the whole broadcast was merely dubbed film; not once did a teacher appear, it was a succession of film shots, tied together by a phantom voice."

In fact, the twenty-five minute programme included seven minutes and forty-nine seconds of film excerpts, the rest being live television. I think it can be taken as a compliment to the cameramen on the excellence of their work in deceiving the reviewer into believing their shots took the time necessary to create film shots.

He goes on to say, "The larger the age-range aimed at, the more wasteful is the broadcast likely to be. . . . It would be better to aim specifically at narrow age-ranges."

If, for instance, a programme is aimed specifically at the fourteen-year-old middle ability range child in the secondary modern school, it might also be used for brighter, younger children or the less able older children. Therefore, Prof. Tolansky's reference to age-ranges seems totally inapplicable. Naturally it is readily agreed that there must be some specific aim.

Prof. Tolansky closed his article by levying what he termed "a really formidable criticism of ITV, for each broadcast is put out at 2.43 p.m. and this is identically repeated an hour later. Surely this is a shocking waste of the most precious of commodities, camera time . . . the right thing is for two programmes for different age-levels."

For a twenty-five-minute schools broadcast the cameras are switched on, half an hour to warm up, three hours for rehearsal and one hour to line up; a total of four and a half hours, not including transmission time.

A further broadcast of the same programme requires no more extra camera time, other than the twenty-five minutes for the transmission and the fifteen minutes break.

Ideal though it may be, I am sure Prof. Tolansky will appreciate that there are not, as yet, the facilities available to mount ten different programmes each week.

JOHN FRANKAU

(Schools Broadcasting Section Associated-Rediffusion)

British Railways do use Computers

Sir:

The section of the editorial in your September issue (DISCOVERY, vol. 19, No. 9, p. 359) which deals with the installation of an analogue computer for work on train performance perhaps does less than justice to the activities of British Railways in using computers. The special-purpose machine described is but one among half a dozen computers of different types now operated by British Railways. The first of these was delivered before the end of 1956, only a few months after the first railway computer installed in the United States, and even today we know of no computers operated by railway administrations outside the United States, Canada, and this country.

It is of course true that most of these machines are used for administrative work and are perhaps of less interest to your readers than machines for scientific work, but for this class of use, too, British Railways are not lagging. A digital computer was installed at their Research Department at Derby in August last, and immediately started productive work in reducing and analysing the data from an extensive series of trials into the rolling resistance of freight wagons (information essential to the designers of the most modern type of marshalling yards). This computer is destined to be used not only for data reduction but in the many complicated problems which arise in railway research and engineering. It is the first of its type to be used in this country and, we believe, the first digital computer in the world to be acquired solely for railway research and engineering.

British Railways, too, have for some time been using digital computers at service bureaux for particular problems: the first such example was the calculation on *Leo I* of the minimum distances by rail between all the 6000 goods stations in Great Britain. This information was necessary for a new freight charges scheme authorised in 1957 and would have taken a prohibitively long time by manual methods. British Railways have made use also of *Deuce* for the calculation of train performance using the programme written by a former railwayman and described at the IEE Computer Conference in the spring of 1956.

British Railways are looking to the future and have a number of active investigations in hand. Railwaymen have been working for over a year in each of two commercial computation centres, devising means to use a computer to make timetables. This has proved to be a task unlike any familiar to the computer experts, but they have satisfied themselves, and the authorities, that it can be done, though many details remain to be worked out. If the economics of the process prove to be equally satisfactory, the result should be improved timetables with a higher utilisation of our facilities. Again, the universities are helping us in trying to take advantage of similarity in the logical principles in the design of a railway signal-box and of a computer, a similarity in logic which may perhaps be extended with advantage to a similarity in engineering design. In another direction, one of the computer firms is collaborating with a railway region and the British Railways Operational Research Division in trying to find out if linear programming has a practical application to the distribution of empty freight wagons; if it has, the calculations will be a task for a digital computer.

British Railways claim no monopoly in imagination, and would welcome suggestions for further fields in which computers could serve them, either by enabling them to provide a better service, or by reducing the costs of the present service. But British Railways do claim that the caption "At Last" could almost be replaced by "At First".

J. H. BREBNER, O.B.E.

Public Relations Adviser to the British Transport Commission.

"Transport Calculus"

Sir:

Your article "Transport Calculus" omits all reference to a major factor in the transport problem. We inherited from our forefathers the skeleton of a splendidly integrated system of canals and inland waterways which we have allowed to rot into utter decay. This system, modernised at far less than the cost of the proposed motorways, would be capable of removing from the roads the bulky and heavy traffic which is the main cause of the congestion. It is to be hoped that as a result of the Bowles Report the Government will take action which will result in the courageous and imaginative management of our canals, and make a real contribution to resolving the country's traffic problem by reviving the noble legacy of Brindley and Telford.

L. G. LOWRY

Haywards Heath, Sussex.

FAR AND NEAR

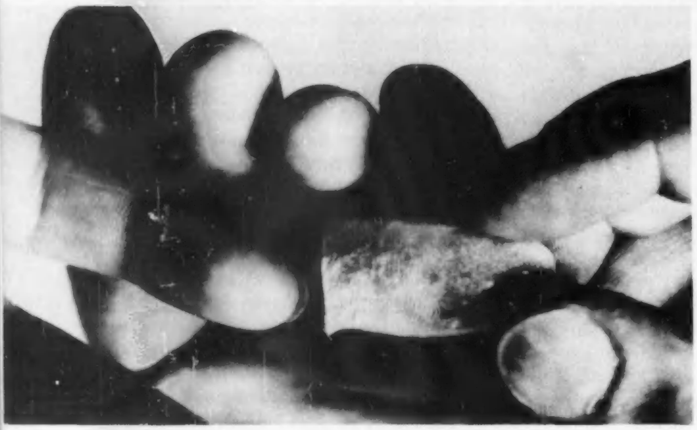
AMERICAN SCIENCE IN PICTURES

TRANSPORT FOR WAR AND PEACE

FIG. 1. (*Left*) A precision "tracking" ability is incorporated into the design of the United States Army's new Overland Train. Unique features include all-wheel drive for the 52 wheels which mount tyres 10 ft. high and 4 ft. wide. This 450 ft. long 12-unit vehicle is designed to transport heavy cargo in Arctic regions and in other remote world areas lacking land transportation facilities.

FIG. 2 (*Below*) By clean, simple, and clever design, the Italian coach-builder Pinin Farina demonstrates how even a big Cadillac cabriolet can appear low and sleek.

(*Shell photograph*)



PLASTIC FINGERPRINTS

FIG. 3. (*Above*) A new method of taking fingerprints permanently embeds the impression of a direct or latent fingerprint on to a tough plastic film which can be easily handled without smudging. It thus provides a permanent record and a positive means of identification.

FIG 4. (*Below*) These pictures show contrast between (*left*) a fingerprint taken by the conventional rolled-ink method and (*right*) one made with liquid nylon compound spray.

RADIO TELESCOPE

FIG. 5. The largest steerable radio telescope in the United States has recently been completed at the United States Naval Research Laboratory at Maryland Point Observatory in Charles County, Maryland. The instrument, which has an 84-ft. parabolic antenna or "dish", was designed by the D. S. Kennedy Company of Cohasset, Massachusetts. The aluminium reflector is carried on a Polar or equatorial mount, can be aimed at any point in the sky, and can track celestial objects from horizon to horizon. The telescope will be used for studying the radiation of the sun and moon in detail, for searching for radiation from the galaxy, and for pinpointing optically invisible objects.

Photograph shows how a technician makes adjustments to the radiometer mounted at the focus of the 84-ft. parabolic antenna while standing on top of a 40-ft. telescoping platform lift.

INFRA-RED PHOTOGRAPHY

FIGS. 6 and 7. The thermograph is an infra-red device used for taking photographs in the dark. The "heat" or infra-red radiance emitted by an object or person being photographed creates the image on film in a Polaroid land camera. Ghost-like figures are examples of pictures taken by the thermograph. (The man on the right really has only one leg.)

Science in Parliament

Tuesday, October 28 saw the State Opening of Parliament by Her Majesty the Queen. This was a unique occasion, symbolic of a new scientific era, because for the first time the ceremony and the Speech were televised for millions to witness.

As the session proceeded, matters of scientific interest arose. During question-time on November 3, further information was sought as to Britain's intentions regarding the launching of an earth satellite, and it was suggested that if shortage of funds were an obstacle, the participation of the Commonwealth Governments should be sought. The Government stated that it had the problem of space research under examination with numerous scientific authorities, including the Royal Society. The matter of finance was not the immediate issue: the problem was one, *pace* Lord Rutherford, of "thinking"—that is, what scientific value could be obtained from such a programme.

A wide range of routine questions relating to scientific research and education was overshadowed by news of progress of the Development of Inventions Bill through the Commons. This Bill received its second reading on November 14; it seeks to lengthen the period of, and the financial limit on, advances which the Government makes, by a further ten years and £5 million respectively, to the now ten-year-old National Research Development Corporation. Information was given on the progress of the Corporation, which already holds nearly 1000 British and 2000 overseas patents. Whereas in 1954 its gross annual income was £30,000, this had currently risen to almost £200,000, more than covering the Corporation's administrative expenses, and it had become practicable not to renew the clause permitting the Corporation to waive its current interest payments. It was still too early to judge whether the Corporation would ultimately prove self-supporting; indeed, Opposition spokesmen argued that this process would be facilitated if projects regarded as non-profitable yet eminently necessary, were categorised separately.

Apart from its impressive record in developing inventions emerging from public research, the Corporation had more recently been called on to undertake research to solve specific problems. As to its important duty of developing seemingly worth-while, but hitherto neglected private inventions, the Government spokesman drew reassurance from the fact that the Corporation had been asked to do very little in this field.

Tributes were paid to Lord Halsbury, Managing Director of the Corporation, and mention was made of important research projects sponsored: *inter alia* control gears for the stabilisers of the *Queen Mary;* "sea-serpents"—large flexible bags for oil transport; the development of a patents pool for the virtually new indigenous electronic computer industry. Yet while scientists will welcome the bi-partisanship pervading the deliberations, they will regret that an issue so vitally affecting the whole level of innovation in British industry was relegated to a mere Friday morning debate.

Human Relations, Efficiency and Industry

On October 16 the Final Report of the Joint Committee on Human Relations in Industry 1954–7 and the Report of the Joint Committee on Individual Efficiency in Industry 1953–7 was published in one volume. This was the end result of a large amount of work, for apart from detailing their sponsorship of research projects totalling nearly £250,000, the Committees make important observations on the future of research in their respective fields. That the Committees are now disbanded does not lessen the significance of their comment, for the purview of their operations will fall within the new permanent Human Sciences Committee of the DSIR and the MRC itself.

Particularly welcome is the realisation that the financing of social research from public funds should provide for work of a long-term character, and the corollary that here, as in the physical sciences, fundamental, like applied research, has its role. While many recommendations are made for the better gearing of social research to industry, it is recognised that there is no single panacea. A major obstacle, however, is the complexity of technical writing: hence a proposal for reports at two levels, including one short version, clearly written and severely practical.

Nevertheless, research should not all be utilitarian and directed to satisfy purely economic needs. Human relations are important in their own right: thus, given the different viewpoints arising in industry, it is essential that the research worker should always maintain his impartiality.

Despite encouraging news of specific projects, there are grounds for grave concern, notably at the lack of industrial training schemes and the acute shortage of good research workers, especially in the senior grades. While it is reassuring that the Human Sciences Committee of the DSIR accepts most of the proposals made, and will help carry on the Committees' work, one would nevertheless wish for a more urgent approach to the manpower problem.

Experimental Research into Problems of Ageing

The trustees of the Ciba Foundation, 41 Portland Place, London, W.1, wishing to encourage well-conceived research relevant to basic problems of ageing, invite candidates to submit papers descriptive of work in the field for the fifth and final annual awards for 1959.

Copies of the regulations and form of application must be obtained from the Director and Secretary to the Executive Council, G. E. W. Wolstenholme, before an entry is submitted, but in general candidates should note:

(*a*) Not less than five awards, of an average value of £300 each, are available for 1959. The announcement of awards will be made in August 1959.

(*b*) Entries must be received by the Director not later than January 10, 1959.

(c) Entries will be judged by an international panel of distinguished scientists, including: Prof. C. H. Best (Toronto), Prof. E. Braun-Menendez (Buenos Aires), Prof. E. J. Conway (Dublin), Prof. G. W. Corner (New York), Prof. A. Haddow (London), Prof. V. R. Khanolkar (Bombay), Prof. R. Nicolaysen (Oslo), Dr A. S. Parkes (London), Prof. F. Verzár (Basle), and Prof. F. G. Young (Cambridge). They will advise the Executive Council of the Foundation on their findings and will also have power to recommend variation in the size and number of the awards according to the standard of entries. The decisions of the Executive Council will be final.

(*d*) In making the awards, preference will be given to younger workers.

(*e*) The papers may be in the candidate's own language. Papers should not be more than 7000 words in length and in all cases a summary in English not exceeding in words 3% of the length of the paper must be attached. If possible, ten copies of reprints in English should be provided.

(*f*) Where there is one or more co-author, the name of the leading author should be indicated; it is to him that the award will normally be made, and it will be left to his discretion to share this award appropriately with his co-authors.

Submarine Volcano in the Arctic

The presence of an active underwater volcano has been established in the Central Arctic basin, according to Soviet scientists. This conclusion was reached after members of a drifting polar research station had registered strong tremors in the pack-ice in the vicinity of the submarine Lomonosov mountain ridge.

Ferodo Looks Ahead

At the end of November 1958 Ferodo's new research laboratories were opened by the Duke of Edinburgh. In sixty-one years this Company has grown from a shed costing £25, where Herbert Frood conducted his first researches on friction—and subsequently produced a woven asbestos fabric spun on brass wire—to this vast laboratory which cost £750,000 to build.

The work of the laboratories may be divided into four principal groups: to begin with fundamental research into friction and raw materials, which includes the problem of what friction really is, and the study of the properties of asbestos; then development and improvement of new and existing types of brake linings—finely powdered metals and/or ceramics which are compressed and combined by sintering at a high temperature just below melting-point; thirdly, testing friction materials on specially designed machines and on cars, buses, and lorries out on the open roads—all linings are subjected to exhaustive tests on machines and on the road before going into full-scale production; and finally, designing methods of manufacturing materials in the factory whereby new plants and techniques are worked out before large-scale production starts.

Research has been the basis of the success of Ferodo Ltd in the past and the new laboratories should ensure that the Company retains its leading position in the future.

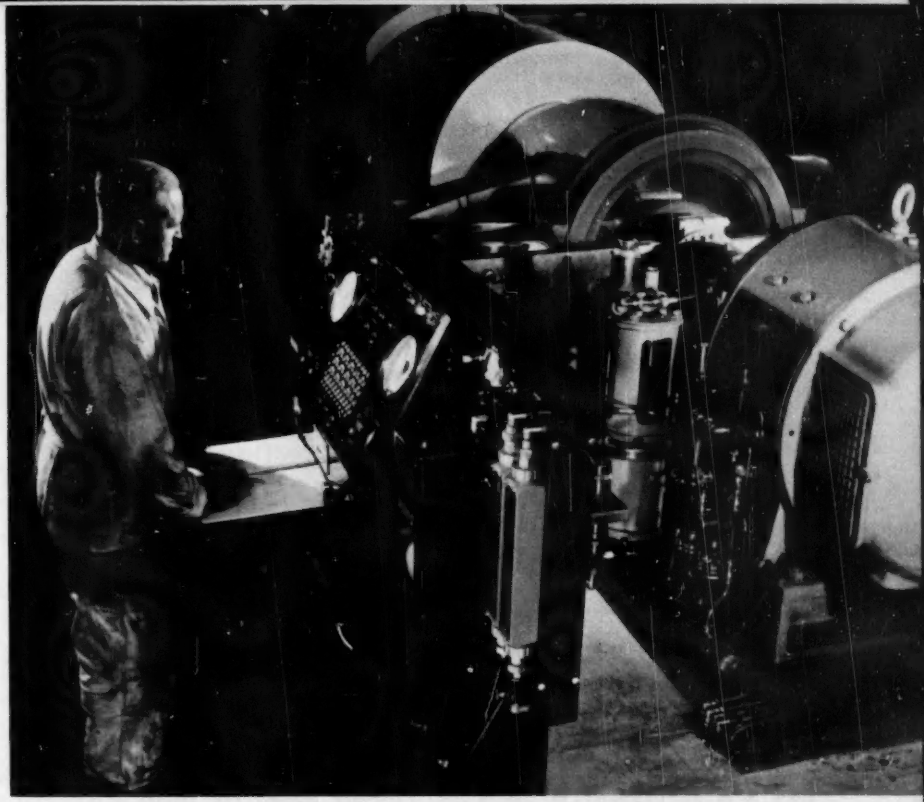


FIG. 8. Railway blocks are being tested against a railway wheel on a large inertia dynamometer machine in the test-house. The control panel records torque pressure and block pressure, indicates stopping time, revs per minute, and provides a facility for recorder selection.

Scientific Buying

The Consumer Association Ltd is a non-profit-making organisation whose purpose is to make tests of different goods and services available to the general public. Before the Association was established the consumer had few guides to the quality of a product except advertisements, displays, elegant packaging, and so forth. The Association's intention is to tell the public the exact performance and use of any specific articles, and they base their results on sound scientific tests. The goods to be tested are bought from general retailers throughout the country and sent to different laboratories and universities for the examinations, and the result of these tests are then published in their quarterly journal, *Which?* The Association tries to examine as large a variety of goods as possible; for example some of the most recent tests have included washing machines, Biro pens, drip-dry garments, and an inquiry into "cut-price" groceries.

A questionnaire was recently sent to members asking them to state what goods and services they would like to have tested. Detergents headed the list and were followed in popularity by paints and refrigerators.

In addition to the above examples, the Association is also trying to alter some of the agreements, or contracts, that a consumer automatically has to make when receiving various services. They hope to be able to satisfy the consumer but at the same time safeguard the retailer.

The Association runs on subscriptions from members who now number over 100,000. It hopes in the future to enlarge this to a quarter of a million in order to raise funds for testing a larger number of goods. If this ambition should be realised the Association will then issue *Which?* monthly instead of quarterly.

Raising Funds for New School Laboratories

Bryanston School is having more difficulty than most schools in raising money for its new building, since it is a young public school and has no endowments. The Industrial Fund for the Advancement of Scientific Education in Schools has given £30,000. The school decided to build a new Biology wing at the same time as the Physics and Chemistry wings, though there was no grant for it. This meant that Bryanston had to raise £40,000 for the balance of the Physics and Chemistry wings, for the entire Biology wing, and for providing gas and electricity and other services to the site.

Two dinners were held in London to which representatives of firms which had not contributed to the Industrial Fund were invited. These dinners were the main source of the £20,000 so far raised. Some firms gave equipment rather than money.

Old Boys are arousing interest in firms unknown to Bryanston. One Old Boy living in New York is hoping to arrange a dinner in America. Well-known artists as well as Old Boys have contributed pictures which are being raffled by present members of the school. The Dramatic Society performed a play in London last year, and the Jazz Band gave a concert. This year "King Lear" is being performed in London on two nights by the Dramatic Society in aid of the Fund.

It is significant that the Arts side of the school is playing a large part in the raising of funds.

OEEC Countries to Study Halden Reactor

The new Norwegian atomic reactor at Halden in South Norway, which will ultimately produce steam for a wood pulp factory, will be operated as an experimental reactor for some time under the auspices of the OEEC and in co-operation with the atomic institutes of the interested countries.

Classified Advertisements

OFFICIAL APPOINTMENTS

SCIENTIFIC OFFICER OR SENIOR SCIENTIFIC OFFICER, ROYAL OBSERVATORY, CAPE TOWN. Pensionable post for a man at least 21 and under 31 on 1/12/58; age extensions for regular Forces services and Overseas Civil Service. Qualifications: Ph.D. in Astronomy or allied subject; or appropriate Science Degree (First or Second Class Honours) with at least 3 years' relevant (e.g. post-graduate) experience. Knowledge of celestial mechanics an advantage. Starting salary on scale (£S.A.) 600–1020 or 1060–1290 according to age and experience plus cost of living allowance of (£S.A.) 234 for married man. Promotion prospects. Write for application form to Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting S4910/59. Closing date, January 8, 1959.

D.S.I.R. require ASSISTANT PUBLICATIONS OFFICER (man or woman) at Building Research Station, Garston, Herts., to prepare publications for building industry based on Station's chemical, physical, engineering and operational research. Pass Degree in Science Subjects and industrial experience including writing of technical reports desirable. Salary (men 26 or over) £920–£1130. Forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, (quote A.455/8A). Closing date, January 15, 1959.

APPOINTMENTS VACANT

ENGINEERS AND PHYSICISTS

WELL-QUALIFIED GRADUATES are invited to apply for appointments to our Research Staff for work in the following fields:

(1) Electrical insulation in service;

(2) Processes and application of low-voltage arcs and discharges.

Posts (1) are at Leatherhead, Posts (2) at Perivale, Middlesex. Working conditions are liberal, with opportunities for publication. Initial salaries offered will be within the range of £700 to £1100 p.a. Candidates with Ph.D. or some research experience preferred, but recent graduates will be considered. Applications to The Secretary, ELECTRICAL RESEARCH ASSOCIATION, Cleeve Road, Leatherhead, Surrey.

LECTURES AND COURSES

FARADAY HOUSE ELECTRICAL ENGINEERING COLLEGE

A THREE-YEAR COURSE, commencing each term, in Electrical Engineering to qualify for Associate of Faraday House and Graduate of the Institution of Electrical Engineers, followed by one year's practical training in Industry to qualify for the Diploma of Faraday House. For Prospectus apply to Department "E", Faraday House Electrical Engineering College, 66 Southampton Row, London, W.C.1.

UNIVERSITY OF LONDON

DEPARTMENT OF EXTRA-MURAL STUDIES

SIX UNIVERSITY EXTENSION LECTURES at ST BARTHOLOMEW'S MEDICAL COLLEGE, E.C.1, on

AIR POLLUTION:
NATURE, EFFECTS, AND PREVENTION

Main lecturer and director of the course is Dr P. J. Lawther, Director of the Group Research on Atmospheric Pollution. On TUESDAYS at 6.30 p.m. Begins January 20, 1959. Fee: 15*s*.

Applications for the above course should be made to Deputy Director (Ext. D.), Extra-Mural Department, Senate House, W.C.1.

PUBLICATIONS

THE HUMANIST is the journal of Scientific Humanism (monthly 1*s*., p.a. 14*s*.) Spec. copy. "Living with Reality", and Bertrand Russell's "Faith of a Rationalist", free. RPA (Dept. D), 40 Drury Lane, W.C.2.

WANTED

MICROSCOPES

Highest prices paid for good types

**WALLACE HEATON LTD,
127 New Bond St. London, W.1**

SCIENCES

and a few Arts

The rapidly developing Albright & Wilson group of chemical companies can provide opportunities for high calibre graduates in chemistry and chemical engineering, and occasionally for outstanding Arts graduates.

Albright & Wilson Ltd., one of the largest chemical manufacturing organisations in the country, has seven production plants in Great Britain employing approximately 5000 people. The products of this expanding group of companies consist mainly of phosphorus, phosphoric acid and phosphates, chlorates, sulphuric acid, detergent chemicals, oil additives and silicones.

There are openings in research, technical service, production management and sales, together with engineering design and maintenance, and administration. Additionally the overseas companies of the group in Canada or Australia can sometimes provide suitable opportunities.

Please write for our brochure which gives you full information about the possibilities that exist with us.

THE STAFF OFFICER CENTRAL PERSONNEL DEPARTMENT

Albright & Wilson Ltd

OLDBURY · BIRMINGHAM

TBW/578A

Printed and published in Great Britain by Jarrold & Sons Ltd, Norwich

Editorial Office: 244 High Holborn, W.C


SKYLARK